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AN ESSAY ON GOLD COIN.

IN WHICH IS SHEWN

The General Use of Currency, and the Present State of our Gold Coin; with Arguments to prove the Neceſſity of a New Coinage; pointing out the diſtinct Value and Weight that each Piece of Gold ought to be of.

ALSO

THE PRINCIPLES OF HYDROSTATICS, Shewing how to diſcover any Adulteration in Gold Coin, either by the Pen, or Tables ready calculated to ſhew the Par of Weight of each Piece, either in Air or Water.

WITH A

DESCRIPTION and USE of the moſt improved WEIGHING INSTRUMENTS; ſhewing their Properties when really accurate.

INTENDED

For the Service of BANKERS, PUBLIC OFFICES, and Trade in General.

To this Edition is ſubjoined the Subſtance of the late Gold Act; with Anſwers to the very ſevere Strictures upon it, &c. in a Tract intitled A Critical Enquiry, &c.

By THOMAS HATTON,
Author of a Treatise upon Clock and Watch Work.

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THE SECOND EDITION.

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Gold Coin

TO THE

RIGHT HONOURABLE

LORD NORTH.

My LORD,

UPON the Appearance of the late Gold Act, I collected my Thoughts upon a Matter that might add to the Security of the Fair Trader, which naturally appeared wanting from the Strictneſs of the Act; for as the unlawful Practice of diminiſhing the Gold Coin was perfectly ſtopped thereby, there remained no other Reſource for the

Iniquitous, but Adulteration. I flatter myſelf, my Lord, that by what is laid down in the enſuing Eſſay, every one may be guarded againſt even that. I have therefore given every Obſervation I thought neceſſary to its Nature in this Edition, and added ſome Remarks on the Ignorance or deſigned Partiality of a late Writer, who has made very ſcurrilous Attacks upon Adminiſtration. I remain,

My Lord,
With the utmoſt Reſpect,
Your Lordſhip's moſt obedient
humble Servant,

THOMAS HATTON.

PREFACE.

SINCE the firſt Edition of this Tract, the Public have been favoured with various Opinions, Cenſures, and Invectives againſt the Miniſtry, for the late Gold Act, which was much wanted, to ſecure the Property of the Fair Trader againſt the artful Cheats of Sweaters, Clippers, &c. of the Gold Coin of this Kingdom. It does not appear to me, how an immediate Stop could have better been put to the daring Trade of diminiſhing the Currency than what has been done by the Act in queſtion, which, after the uſual Formality, concludes thus: "You "are in ſuch Caſe to take it for granted, that "every Piece of Gold Coin that is leſs in "Weight than is hereunder ſpecified, has "been unlawfully diminiſhed, and are ac-"cordingly to deface it." The Weights mentioned are to be as in this Table.

	Dwts.	Gr.
Guineas coined prior to the 1ſt of Geo. III	5	3
Half-Guineas, during the above Period -	2	13
Guineas coined during the Reign of his preſent Majeſty, and previous to the Firſt of Jan. 1772 — — —	5	6
Half-Guineas, during the ſame Period -	2	14
Quarter-Guineas — — —	1	7
Guineas ſubſequent to the 1ſt of Jan. 1772	5	8
Half-Guineas — — —	2	16

the following Work I have ſaid that the ſtated Price is *near par*. Upon this ſimple Miſtake is all the reſt of his Pamphlet founded, and from it he is induced to throw out a Load of Scurrillity againſt the Treaſury, Bankers, and other Dealers in Coin, who are as innocent of the Cheat laid to their Charge, as he is in want of Judgment in this Matter.

AN ESSAY ON GOLD COIN, &c.

Of the firſt Principles of HYDROSTATICS.

THE alarming State of the current Gold Coin of this Kingdom, through the infamous and daring Practices of Coiners, Clippers, Sweaters, &c. in diminiſhing and counterfeiting the Gold Species of every Kind, juſtly drew the Attention of Adminiſtration, who determined by Authority to reſtrain the growing Evil; accordingly an Act was paſt for "the better preventing the counterfeiting, "clipping, and other diminiſhing the Gold Coin "of this Kingdom;" by which the Circulation of Gold Coin, which appeared to be diminiſhed, or lighter than what could be the Conſequence of reaſonable Wearing, was prohibited. A general Alarm now ſpread itſelf through the Nation; every one was cautious what Gold he received in Payment; all Pieces underwent Inſpection: which Delay and Particularity became of Neceſſity very great Impediments to Buſineſs in general; and the Difficulty of procuring a ſufficient Quantity of heavy Pieces of Gold to make regular and prompt Payments, hurt the Poor in particular; for the Multitude of light Guineas, Half-Guineas, and

Quarter-Guineas, which were daily cut, and conſigned to the Melting-Pot, not to mention the almoſt total Rejection of *Portugal* Pieces, rendered Currency ſo ſcarce that Trade felt a ſenſible Shock; and as every Perſon was willing to be on the Side of Security, while many ſtill attempted to put off their light Gold, there became an almoſt univerſal Demand for Scales to aſcertain the Weight of Gold Coin; but none of thoſe in common Uſe, nor any Invention generally known, were found adequate to the Purpoſe required; for beſide their not being critically accurate, they could only determine the Weight of the Piece ſtatically, or by weighing it in the Air, but not the ſpecific Gravity or intrinſic Value of the Piece; which is to be done with Preciſion by Hydroſtatics only, or weighing the Piece in Water.

It is a received Opinion among the Generality of People, that if a Piece of Gold is full Weight, it muſt of courſe be perfectly good. Hence the Coiners have taken Advantage of ſuch an ill-founded Prepoſſeſſion, and by the moſt ingenious Modes of Adulteration, have made Guineas, Half-Guineas, and Quarter-Guineas, which have been full Weight, when weighed in the Air only, ſeem to the Eye to be pure Gold, will ring well, and even ſtand the Touch-ſtone; yet, by a moſt artful Contrivance, the Adulteration is ſo great, that they contain but very little Gold, and are but of trifling Value. The only Way to detect ſuch Pieces is by the Methods here preſcribed, and the New-Invented Inſtruments whoſe Deſcription and Uſe we here preſent to the Public; for thereby may be diſcovered the diſtinct Quantity of each Kind of Metal whereof any Piece of Coin is compounded, whether Gold, Silver, Braſs, Copper, &c. and the Methods are ſo certain, that no Diſguiſe or Art whatever can elude it.

As the Original of the Invention of this Method of diſcovering the intrinſic Value of Metals, and the firſt Riſe of the Laws of Hydroſtatics, is extremely curious, I ſhall here relate it.

Hiero, King of *Syracuſe*, having delivered to an Artificer a certain Quantity of Gold, in order to make a Crown, he had Intelligence that the Workman had clandeſtinely embezzled great Part of the Gold, and in the Room thereof had ſubſtituted a Quantity of Silver, ſufficient to make up for the Deficiency of Weight.

The King, when the Artificer delivered the Crown to him, found it ſo excellently well executed, that he was unwilling to have it defaced in order to detect the Villainy of the Man; but ſtill having a Curioſity to know how much Gold he had been cheated of, he applied to *Archimedes*, the celebrated Mathematician, and ordered him, if poſſible, to diſcover, without injuring the Work, how much Gold was deficient.

To effect which, *Archimedes* took two Quantities of Metal, the one Gold and the other Silver, each equal in Weight to the Crown; theſe he ſeparately immerſed in a regular Veſſel of Water, and remarked what Room they both took up by the riſing of the Water in the different Veſſels.

Then finding that they each took up the Room of different Quantities of Water, he concluded that their ſpecific Gravities muſt be different. Their ſpecific Gravities he then compared to their abſolute Gravities, with their Relation to the Gravity of the Water.

Having then immerſed the Crown itſelf in the Water in the ſame Manner, he compared his different Obſervations together, and by that Means aſſigned the Quantities of Gold and Silver reſpectively which the Crown contained, and thereby detected the Cheat which the Artificer had put upon the King.

It will now be neceſſary to lay down the univerſal Law upon which Hydroſtatics is founded, firſt diſcovered by *Archimedes*, and ſince adopted by the Philoſophers of every Age and Nation; which is this:

If any ſolid Body, whoſe Weight hath been aſcertained in Air, be immerſed in Water, it will loſe juſt as much of its Weight in the Fluid, as the Weight is of ſo much of the Fluid as would fill the Space taken up by the immerſed Solid.

If the Weight of any ſolid Body be known in Air, which Body is heavier than Water, its hydroſtatic Weight, or its Weight in Water, may eaſily be found; for it will be exactly as much leſs as a Quantity of the ſame Fluid equal in Weight to the immerſed Solid.

Therefore if the Weight of the Fluid be ſubtracted from the Weight of the Solid in Air, the Remainder will be the hydroſtatic Weight of that Body, and their Difference will be the Standard by which the Goodneſs of the Metal may be tried.

I ſhall now, by a Table, ſhow the Proportions of ſpecific Gravity that ſeveral Bodies, both ſolid and fluid, bear to each other; with the Weight, both in Troy and Avoirdupoize, of a cubic Inch of each Body, from whence the hydroſtatic Gravity may be found; and likewiſe, by having the Weights of Bodies, their Solidities may be found; and, on the contrary, by having their Solidity, their Weights may be diſcovered.

TABLE of SPECIFIC GRAVITY.

Species.	The relative Weight of Bodies.	Troy Weight. Oz. Decimal Parts.	Averdupois Wt. Oz. Decimal Parts.
Fine Gold	19,640	10,360100	11,365668
Standard Gold	18,888	9,963420	10,929478
Lead	11,340	5,981350	6,562458
Fine Silver	11,092	5,851030	6,418940
Standard Silver	10,536	5,557740	6,097183
Copper	9,000	4,747500	5,208300
Copper Halfpence	8,915	4,702662	5,159111
Fine Braſs	8,350	4,404625	4,832145
Caſt Braſs	8,100	4,272750	4,687470
Steel	7,850	4,140875	4,542795
Iron	7,644	4,032210	4,423583
Pewter	7,471	3,940943	4,323468
Tin	7,320	3,861300	4,236084
Caſt Iron	7,000	3,692500	4,050900
Lead Ore	6,200	3,270500	3,587940
Quickſilver	14,000	7,565000	8,101800
Sea Water	1,030	,543325	,596061
Common Water	1,000	,527500	,578700
Air	,0012	,000633	,000694

The above Examples are ſufficient to aſcertain the ſpecific Gravity of any Bodies which are requiſite to be mentioned in this Treatiſe.

The following Tables will be found extremely neceſſary in the Courſe of this Work.

TABLE I.

A TABLE of the Static and Hydroſtatic Weight of Gold.

Value.		Static Wt.		HydroſtaticWt.	
£.	S.	Pwt.	Gr.	Pwt.	Gr.
0	1	0	6	0	5¾
0	2	0	12	0	11⅓
0	3	0	18	0	17
0	4	1	0	0	22¾
0	5	1	6	1	4½
0	6	1	12	1	10
0	7	1	18	1	15¾
0	8	2	0	1	21½
0	9	2	6	2	3
0	10	2	12	2	8¾
0	11	2	18	2	14½
0	12	3	0	2	20¾
0	13	3	6	3	2
0	14	3	12	3	7½
0	15	3	18	3	13¼
0	16	4	0	3	19
0	17	4	6	4	0½
0	18	4	12	4	6⅓
0	19	4	18	4	12
1	0	5	0	4	17½
1	1	5	6	4	23⅓
1	2	5	12	5	5
1	3	5	18	5	10¾
1	4	6	0	5	16½
1	5	6	6	5	22
1	6	6	12	6	3¾
1	7	6	18	6	9½
1	8	7	0	6	15
1	9	7	6	6	20¾
1	10	7	12	7	2½
1	11	7	18	7	8¼
1	12	8	0	7	14
1	13	8	6	7	9¼
1	14	8	12	8	1½
1	15	8	18	8	7
1	16	9	0	8	12½
1	17	9	6	8	18¼
1	18	9	12	9	0
1	19	9	18	9	5½
2	0	10	0	9	11⅓
2	1	10	6	9	17
2	2	10	12	9	22¾
2	3	10	18	10	4⅓
2	4	11	0	10	10

Value.		Static Wt,			HydroſtaticWt.		
£.	S.	Oz.	Pwt.	Gr.	Oz.	Pwt.	Gr.
2	5	0	11	6	0	10	15¾
2	6	0	11	12	0	10	21⅓
2	7	0	11	18	0	11	3
2	8	0	12	0	0	11	8¾
2	9	0	12	6	0	11	14½
2	10	0	12	12	0	11	20
2	11	0	12	18	0	12	2
2	12	0	13	0	0	12	7½
2	13	0	13	6	0	12	13¼
2	14	0	13	12	0	12	19
2	15	0	13	18	0	13	0½
2	16	0	14	0	0	13	6¼
2	17	0	14	6	0	13	12
2	18	0	14	12	0	13	17½
2	19	0	14	18	0	13	23¼
3	0	0	15	0	0	14	5
3	1	0	15	6	0	14	10½
3	2	0	15	12	0	14	16⅓
3	3	0	15	18	0	14	22
3	4	0	16	0	0	15	3¾
3	5	0	16	6	0	15	9⅓
3	6	0	16	12	0	15	15
3	7	0	16	18	0	15	20¾
3	8	0	17	0	0	16	2½
3	9	0	17	6	0	16	8
3	10	0	17	12	0	16	13¾
3	11	0	17	18	0	16	19½
3	12	0	18	0	0	17	1⅛
3	13	0	18	6	0	17	6¾
3	14	0	18	12	0	17	12½
3	15	0	18	18	0	17	18¼
3	16	0	19	0	0	17	23⅓
3	17	0	19	6	0	18	5½
3	18	0	19	12	0	18	11¼
3	19	0	19	18	0	18	17
4	0	1	0	0	0	18	22½
8	0	2	0	0	1	17	21
12	0	3	0	0	2	16	9¾
16	0	4	0	0	3	15	18⅛
20	0	5	0	0	4	14	18
24	0	6	0	0	5	13	15½
32	0	8	0	0	7	11	12¾
40	0	10	0	0	9	9	12¾
48	0	12	0	0	11	7	8

TABLE II.

A TABLE of the Static and Hydroſtatic Weight of Gold Coins, with their Value and Difference.

Species.	Value. l.	s.	d.	Static Wt. Pwt.	Gr.	Hydroſtatic Wt. Pwt.	Gr.	Difference. Pwt.	Gr.
1/16 of a Moidore —	0	2	8¼	0	16⅔	0	15¾	0	1
⅛ of ditto — —	0	3	4½	0	20¾	0	19¾	0	1
⅛ of a Johannes —	0	4	6	1	3⅝	1	2⅙	0	1½
¼ of a Moidore —	0	6	9	1	17½	1	15⅙	0	2⅛
¼ of a Johannes —	0	9	0	2	7¼	2	4⅓	0	3
½ of a Guinea —	0	10	6	2	16½	2	13	0	3½
½ of a Moidore —	0	13	6	3	11⅛	3	6¾	0	4⅓
½ of a Johannes —	0	18	0	4	14½	4	8⅚	0	5¾
A Guinea — —	1	1	0	5	9	5	2⅛	0	6⅞
A Moidore — —	1	7	0	6	22¼	6	13½	0	8¾
A Johannes — —	1	16	0	9	5	8	17⅓	0	11⅔
A Two-Guinea Piece	2	2	0	10	18	10	4⅓	0	13⅔
A 2½ Moidore ditto	3	7	6	17	7½	16	9⅝	0	21⅞
A Double Johannes	3	12	0	18	10	17	10⅔	0	23⅓
A Five-Guinea Piece	5	5	0	26	21	25	10⅞	1	10⅛
A Five-Moidore Piece	6	15	0	34	15¼	32	19¼	1	20

TABLE III.

A TABLE ſhewing the Value of the Deficiency of Gold by the Hydroſtatic Weight, when it is adulterated with Silver.

Grains wanting.	Value. l.	s.	d.	Grains wanting.	Value. l.	s.	d.
1	0	3	10½	16	3	2	0½
2	0	7	9	17	3	5	11¼
3	0	11	7½	18	3	9	9¾
4	0	15	6	19	3	13	8¼
5	0	19	4½	20	3	17	6¾
6	1	3	3¼	21	4	1	5¼
7	1	7	1¾	22	4	5	4
8	1	11	0¼	23	4	9	2½
9	1	14	10¾	24	4	13	1
10	1	18	9¼	25	4	16	11½
11	2	2	8	26	5	0	10
12	2	6	6½	27	5	4	8½
13	2	10	5	28	5	8	7¼
14	2	14	3½	29	5	12	5¾
15	2	18	2	30	5	16	4¼

Two TABLES, ſhewing the Value of the Deficiency of Gold, by the Hydroſtatic Weight, when it is adulterated with Copper and Braſs.

TABLE IV. TABLE V.

Grains wanting.	Value in Copper. *l.*	*s.*	*d.*	Value in Braſs. *l.*	*s.*	*d.*
1	0	2	$8\frac{3}{4}$	0	2	$3\frac{1}{2}$
2	0	5	$5\frac{1}{2}$	0	4	7
3	0	8	$1\frac{3}{4}$	0	6	$10\frac{1}{2}$
4	0	10	1	0	9	2
5	0	13	$6\frac{3}{4}$	0	11	$5\frac{1}{2}$
6	0	16	$3\frac{1}{2}$	0	13	9
7	0	19	$0\frac{1}{4}$	0	16	$0\frac{1}{2}$
8	1	1	9	0	18	4
9	1	4	$6\frac{3}{4}$	1	0	$7\frac{1}{2}$
10	1	7	$3\frac{1}{2}$	1	2	11
11	1	10	$0\frac{1}{4}$	1	5	$2\frac{1}{2}$
12	1	12	9	1	7	6

TABLE VI.

A TABLE ſhewing the Quality of the Metal by Inſpection.

Species.	Static Wt. Pwt.	Gr.	Silver Hydroſtatic Wt. Pwt.	Gr.	Copper Hydroſtatic Wt. Pwt.	Gr.	Braſs Hydroſtatic Wt. Pwt.	Gr.	Compoſition Hydro. Wt. Pwt.	Gr.
$\frac{1}{8}$ of a Johannes —	1	$3\frac{5}{8}$	1	1	1	$14\frac{3}{4}$	1	$0\frac{1}{4}$	1	$0\frac{5}{12}$
$\frac{1}{4}$ of a Moidore —	1	$17\frac{1}{2}$	1	$13\frac{2}{3}$	1	$18\frac{1}{2}$	1	$18\frac{1}{5}$	1	$12\frac{1}{3}$
$\frac{1}{4}$ of a Johannes —	2	$7\frac{1}{4}$	2	2	2	$0\frac{1}{2}$	2	$0\frac{1}{2}$	2	$0\frac{3}{4}$
$\frac{1}{2}$ of a Guinea —	2	$16\frac{1}{2}$	2	$10\frac{2}{3}$	2	$12\frac{9}{10}$	2	$8\frac{1}{2}$	2	9
$\frac{1}{2}$ of a Moidore —	3	$11\frac{1}{8}$	3	$3\frac{1}{4}$	3	1	3	$0\frac{4}{5}$	3	$0\frac{9}{10}$
$\frac{1}{2}$ of a Johannes —	4	$14\frac{1}{2}$	4	4	4	$9\frac{3}{4}$	4	$0\frac{4}{5}$	4	$1\frac{3}{4}$
A Guinea — —	5	9	4	$20\frac{3}{4}$	4	$1\frac{4}{5}$	4	17	4	18
A Moidore — —	6	$22\frac{1}{4}$	6	$6\frac{1}{2}$	6	$2\frac{1}{8}$	6	$1\frac{3}{4}$	6	$2\frac{1}{4}$
A Johannes — —	9	5	8	8	8	$18\frac{1}{2}$	8	$1\frac{3}{4}$	8	$2\frac{1}{2}$
A Two-Guinea Piece	10	18	9	$17\frac{1}{2}$	9	$3\frac{2}{3}$	9	$10\frac{1}{8}$	9	12
A Double Johannes	18	10	16	16	16	13	16	$3\frac{2}{5}$	16	$4\frac{1}{2}$
A Five-Guinea Piece	26	21	24	$7\frac{3}{4}$	23	9	23	$13\frac{1}{3}$	23	$15\frac{1}{3}$

TABLE VII.

A TABLE ſhewing the Deficiency of Gold by the Hydroſtatic Weight, when adulterated with the Compoſition of Copper, Braſs, &c.

Grains deficient.	Value.		
	l.	*s.*	*d.*
1	0	2	6
2	0	5	0
3	0	7	6
4	0	10	0
5	0	12	6
6	0	15	0
7	0	17	6
8	1	0	0
9	1	2	6
10	1	5	0
11	1	7	6
12	1	10	0

OF GOLD CURRENCY.

THE Coinage of GOLD was introduced for the Diſpatch of Buſineſs, to ſave the Trouble of counting over at every Payment the ſeveral Pieces of Silver Money equal in Value to the Payment to be made; but as Payments are as various as the Pieces of leſs Value are in Number, or rather infinite, it was found neceſſary to coin a Number of Pieces, that the Sums of the Wholes, or their Parts, might make up any the moſt general Totals of thoſe of a leſs Value. The ſame may be ſaid of the Pieces of leſs Value; ſuch as Half-pennies for Farthings, Sixpences and Shillings for Sums of the ſame, &c.

This coining of Pieces, to be equal in Value to a Sum total, either of thoſe of an inferior Value, or of the ſame, ſhould be done with Judgment, to agree with the Conveniency required, and no farther; for to have Silver Two-pences, Three-pences, &c. is worſe than the Sum of the Pieces equal in Value to them, ſince what is gained in the Time of count for one, is loſt in the diſtinguiſhing and finding of the other.

The great Matter required in the Gold Coinage is, that the ſeveral Pieces ſhould be ready in count, eaſy to diſtinguiſh, and underſtand; which is the only Thing deſigned in Trade, for the Sake of all Claſſes of People: To be ready in count, the ſeveral Pieces ſhould be ſuch as to make up a larger Sum without fractional Parts. The Book Accompts of Debtor and Creditor of Great Britain are kept by 20 Shillings for one Pound; therefore the Gold Coin for 20 Shillings ſhould be the ſame, and not 21 Shillings as it is now current; then Five Guineas would be equal to Five Pounds, and ſo on for any other Sum: Alſo if the Guinea was current at 20 Shillings, the leſſer Pieces, or aliquot Parts would be without Parts of leſſer Value, as Six-pences or Three-pences, &c. which give great Confuſion to many, and even the moſt intelligent make great Miſtakes through mere Inadvertency in not remembering the different Fractions of the ſeveral aliquot Parts now current.

To diſtinguiſh Pieces of Coin readily, it is neceſſary that the ſeveral Pieces ſhould not come too near together in Value, in order that their reſpective Sizes may aſſiſt the Imagination by the Senſes of Sight and Feeling, which would naturally offer from their Size and Weight, eſpecially in thoſe that are adulterated; alſo the ſeveral ſmall Pieces ſhould be derived from one, or be the aliquot Parts of it; or, which is the ſame Thing, the ſmalleſt Piece ſhould be a Standard of the firſt Gold Piece, and each ſucceeding larger one, a Multiple of 2, 3, 4, 5, &c. Times of it; which Pieces by their Size and Weight would aſſiſt the Imagination without the Trouble of inſpecting the Marks, &c.

For clearly underſtanding the ſeveral Pieces readily, they ſhould be all of one Sort of Coin, and of that Nation the People are of that are to uſe them; then let the Royal Marks, or Sentence be ever ſo choſen, it will thus become familiar to the People through Uſe only, as well as *Dieu et mon Droit* in the Royal Coat of Arms.

From the foregoing general Obſervations of the Uſe of Gold Coin may be ſhewn the Abſurdity of the current, as well as the Neceſſity of a total Annihilation of the Portugal Pieces, &c. and in their Stead of having other aliquot Parts of the Coin of this Nation.

The current Gold Coins that are moſt in uſe are 10 in Number, viz. 4*s.* 6*d.* 5*s.* 3*d.* 6*s.* 9*d.* 9*s.* 10*s.* 6*d.* 13*s.* 6*d.* 18*s.* 21*s.* 27*s.* and 36*s.* The two firſt have the Objections of being too near in Value, and having fractional Parts in them, which may both deceive the Eye, and often be miſcounted. The Six-and-Ninepence is pretty well for Diſtance in Value, but is a fractional Piece. The Nine Shillings is too near to Half a Guinea, as well as its Double is to a Guinea, which may cauſe the taking of one Piece for another. The other Pieces are about right for the different Values, to produce the Size; but they, as well as the whole Currency, have different Superſcriptions, Marks, &c. which is a ſufficient Cauſe for their Impropriety in general Uſe.

Before a Plan for current Coin can be laid down, it is proper that ſome general Obſervations be made upon the Weights, Values, &c. of the ſeveral Pieces, whether in Uſe now or not. Gold is weighed by Troy Weight, which has 24 Grains in one Penny-Weight, 20 Penny-Weights in one Ounce, and 12

Ounces in one Pound. The Standard of England for Gold Coin is according to the following Proportion, viz. 11 Ounces of fine Gold and one Ounce of Alloy, that is one Pound Troy Weight of Gold (the Alloy of the worſe Metal included) is coined into 44 Guineas and a Half.

The Standard for Silver is 11 Ounces and 2 Penny-Weights of fine Silver, and 18 Penny-Weights of Alloy, that is one Pound Weight Troy, is coined into 62*s.* or 3*l.* 2*s.*

And the Standard for Copper is ſuch, that one Pound Troy of Copper is coined into 46 Half-pennies, or 23 Pence.

N. B. Three new Copper Half-pennies weigh nearly one Ounce Averdupoiſe Weight.

The Weights of Engliſh Gold and Silver Coins, as they come out of the Mint, are according to the following Table.

			Pwt.	Gr.
A	5 Guinea Piece	Weighs	26	21
	2 Guinea		10	18
	1 Guinea		5	9
	½ Guinea		2	16½
	1 Crown Piece		19	8½
	½ Crown		9	16¼
	1 Shilling		3	22
	6 Pence		1	23

The Static Weight of a new Standard Guinea, as appears from the Table, is 5 Penny-Weights 9 Grains, equal to 129 Grains; yet by reaſon of Allowance for the Loſs in wearing, &c. the Guinea is valued at only 21*s.* ſo that every new Guinea is worth 21*s.* 6*d.* the general Par being at the Rate of 4*l.* per Ounce, when taken for its real Value. This is certainly a great Allowance for Wear, and ſhews ſufficiently the Reaſonableneſs of Government in fixing the Weight of Gold Coin from the Dates of the reſpective Pieces, to prevent an unlawful diminiſhing of the ſame.

From the foregoing Table, and the Allowance being deducted for wear, we may make the following Eſtimate of Gold and Silver as per the Table.

One		l.	s.	d.
Pound of Gold	is worth	48	0	0
Ounce of ditto		4	0	0
Pwt. of ditto		0	4	0
Grain of ditto		0	0	2

Alſo the Value of Silver is as follows.

One		l.	s.	d.
Pound of Silver	is worth	3	2	0
Ounce of ditto		0	5	2
Pwt. of ditto		0	0	5¼
Grain of ditto		0	0	0½

The Portugal Pieces are valued in the ſame Proportion as ours, when Allowance is made for Wear: therefore we ſhall find that the particular Value of each Piece are in Proportion to their Weights, which ſhall be ſhewn in a Table of the current Pieces, with their reſpective Weights.

A	s.		Pwt.	Gr.
Three Pound	12	Weighs	18	10
One Pound	16		9	5
Moidore or	27		6	22
Guinea or	21		5	9
18 *s.* Piece			4	14½
13 *s.* 6 *d.* Piece			3	11
Half Guinea			2	16½
Nine Shil. Piece			2	7¼
6 *s.* 9 *d.* Piece			1	17½
Quarter Guinea			1	8¼
4 *s.* 6 *d.* Piece			1	3½

I have placed the Pieces as they decreaſe in Value, that by a Compariſon of any two near of a Weight, a Weight, the Reader may obſerve the exact Proportion that the two Coins bear to each other in Weight and Value.

Though the general Value of Standard Gold be at the Rate of 4*l.* per Ounce, as has been pointed out, yet Government receives light Gold only at the Rate of 3*l.* 17*s.* 10*d.* ½ per Ounce, which is the real Value as delivered out of the Mint. As it may be of great Uſe to have a ready Calculation of all Values from the loweſt Denomination to the greateſt, I ſhall here add a Table of Values at the above Rate, from one Quarter of a Grain in Value, to one Pound Troy in the ſame.

Table for Ounces.

One Pound Troy, or		*l.*	*s.*	*d.*
12 Ounces	are worth	46	14	6
11 ditto		42	16	7½
10 ditto		38	18	9
9 ditto		35	0	10½
8 ditto		31	3	0
7 ditto		27	5	1½
6 ditto		23	7	3
5 ditto		19	9	4½
4 ditto		15	11	6
3 ditto		11	13	7½
2 ditto		7	15	9
1 ditto		3	17	10½

The Table of Penny-Weights.

		l.	*s.*	*d.*	Decimal Parts of a Farthing.
19 Pwts.	are worth	3	13	11¾	,9
18 ditto		3	10	1	,1
17 ditto		3	6	2¼	,2
16 ditto		3	2	3½	,3

		l.	s.	d.	Decimal Parts of a Farthing.
15 ditto	are worth	2	18	4¾	,4
14 ditto		2	14	6	,5
13 ditto		2	10	7¼	,6
12 ditto		2	6	8½	,7
11 ditto		2	2	9¾	,8
10 ditto		1	18	11¼	,9
9 ditto		1	15	0½	
8 ditto		1	11	1¾	,1
7 ditto		1	7	3	,2
6 ditto		1	3	4¼	,3
5 ditto		0	19	5½	,4
4 ditto		0	15	6¾	,5
3 ditto		0	11	8	,6
2 ditto		0	7	9¼	,7
1 ditto		0	3	10½	,8

The Table of Grains, with their Value in the nearest Vulgar Fractions to the Decimal.

		s.	d.	Decimal Parts of a Farthing.
23 Grains	are worth	3	8¾	,2125
22 ditto		3	6¾+¼	,425
21 ditto		3	4¾+½	,6375
20 ditto		3	2¾+¼	,85
19 ditto		3	1	,625
18 ditto		3	0½+¼	,275
17 ditto		2	9 +¼	,4875
16 ditto		2	7 +¾	,70
15 ditto		2	5 +¾	,9125
14 ditto		2	3¼	,125
13 ditto		2	1¼+¼	,3375
12 ditto		1	11¼+½	,55
11 ditto		1	9¼+¾	,7625
10 ditto		1	7½ near	,975
9 ditto		1	5½	,1875
8 ditto		1	3½	,3

		s.	d.	Decimal Parts of a Farthing.
7 Grains	are worth	1	1½+½	,5125
6 ditto		0	11½+¾	,725
5 ditto		0	9½+¾	,9375
4 ditto		0	7¾	,15
3 ditto		0	5¾+¼	,3625
2 ditto		0	3¾+½	,575
1 ditto		0	1¾+¾	,7875
½ ditto		0	0¾+¼	,8937
¼ ditto		0	0½ or near	1,9468

The Uſe of theſe Tables is plain: but I ſhall add an Example. What will 9 Ounces, 17 Penny-Weights, and 18 ¼ Grains, come to at the Rate of 3 *l.* 17 *s.* 10 *d.* ½ per Ounce? Firſt look in the Table of Ounces for the Value of the 9 Ounces, which is found oppoſite 9 to be 35 *l.* and 10 *d.* ½. In the Table of Penny-Weights oppoſite 17 is found 3 *l.* 6 *s.* 2 *d.* ¼, 3 Parts: Alſo oppoſite 18 Grains are 3 *s.* 0 ½, and one fourth of a Farthing, or 275 Parts in Decimals. Laſtly, oppoſite ¼ Grain is one Half-penny near or 1,9468: Theſe four Sums added together, give the full Value to the greateſt Exactneſs. See the Work.

	l.	s.	d.	Decimal Parts of a Farthing.
9 Ounces	35	0	10½	
17 Penny-Weights	3	6	2¼	,3
18 Grains	0	3	0½ + ¼	,275
¼ ditto	.		0½ or	1,9468
	£. 38	10	2 ¼	.0,5218

So the full Value of 9 Ounces, 17 Pwts. 18 ¼ Grains, is worth 38 *l.* 10 *s.* 2 *d.* ¼ and a Half. The Decimal Parts can be no Trouble to thoſe that do not underſtand them, ſince all the Value that can come in Uſe is put in the Form of a Fraction when one Farthing is the Integer, ſo may be added at Pleaſure as well as left out, if choſe to be ſo.

From the Value of Gold, as laid down in Table I. or the general Value, &c. at 2*d.* per Grain, and the Value in the laſt Table, may be obſerved the Cauſe of Difference; for the Value of a new Guinea, as received from the Mint for Currency, is 21*s.* But according to the general Value of Gold, at 4*l.* per Ounce, it is worth 21*s.* 6*d.*; therefore when Government receives Gold back at 3*l.* 17*s.* 10*d.* ½ per Ounce, they do at the ſame Rate as it was delivered out, very near, as appears from the laſt Values.

Now to proceed upon a more regular Plan for proper Pieces of Coin, it has been ſhewn, that the general Value is at the Rate of 2*d.* per Grain, which is very high, for it comes to 4*s.* the Penny-Weight. Hence from the Senſe of Feeling, we may eaſily find, that Pieces near in Value cannot be diſtinguiſhed from each other; and as they muſt be of little Uſe in Count, conſequently one of them is uſeleſs. If two Pieces that differ in Weight Half a Penny-Weight, and one of them be in Value about 5*s.* the Difference will be perceptible from the Senſe of Feeling, which is the firſt great Requiſite in current Coin; for if the other Senſes are over-buſied, that alone will detect, and recall the others if any Impoſition or Miſtake ſhould offer. Therefore, if this be requiſite in ſmall Pieces, the larger ones ſhould be taken in the ſame Proportion, to continue the Uſe of the ſame Senſe, but may be done with leſs Care, as what is wanted in Proportion is ſupplied by Size and a clear Inſcription.

According to this Plan alſo, the Pieces ſhould be ſuch as a Sum of thoſe of a leſſer Value would come near one of a greater. This requiſite will vary the former, but a Mean may be taken between them, ſo as to form a Series of Pieces ſuperior to thoſe in Uſe, and of our own Coin, without the Uſe of *Portugal* Gold, or of making any great Difference in the Pieces we now have.

The aliquot Parts of a Guinea we already have, are Halves and Quarters, which produce Five-and-three-penny and Ten-and-ſixpenny Pieces; if the Guinea be divided by 3, it gives us ſeven Shillings, or by 7, three Shilling-Pieces. From theſe ſeveral Diviſions of the Guinea, we ſhall have a proper Series of Pieces that would anſwer better than the *Portugal* Gold. The Pieces up to one Guinea, would be 3 *s.* 5 *s.* 3 *d.* 7 *s.* 10 *s.* 6 *d.* 14 *s.* and 21 *s.* For higher Pieces, Multiples of the laſt would come in beſt, and be the moſt eaſy to be underſtood; ſuch as 4 Seven-ſhilling Pieces for 28 *s.* 5 for 35 *s.* which two would anſwer all the Properties of the *Portugal* 27 and 36 *s.* Pieces. The foregoing are the moſt ſimple Changes that can be made, and what ſeem neceſſary; but ſtill the Plan, if put in Execution, would be defective, as well as the general State of our Coinage.

Of a better and more general Plan for the Coinage of this Kingdom, to preſerve it pure and undiminiſhed.

IT muſt be admitted that to treat upon the Coinage of any Kingdom, and lay down a general Plan for its Preſervation in the State required, that it may neither increaſe or decreaſe in Quality and Quantity, is a hard Taſk, and requires an abler Writer, as well as a greater Politician, than the Author of this ſmall Tract.

However, the plain Matter is, that the Currency ſhould be equal in Value, with Labour included, to the Price of pure Gold or Silver; and as this ſhould be the general Maxim of all the States of Europe, it may be generally ſuppoſed, that the reſpective Coins of each Kingdom would remain the ſame, without any Variation of it by Commerce, &c. For if the Coinage was equal in Value to pure Gold and Silver, no one would give his Labour in coining it; and an Adulteration of the ſame would eaſily be detected by the known Laws of Hydroſtatics.

But it would alſo require that the Plate uſed in Utenſils, Trinkets for domeſtic Uſe, &c. or grand Ornaments, ſhould be of the ſame Purity of the current Coin.

The foregoing general Maxim would be the ſame, if the Bullion of Europe be kept ſcarce, and the Currency be adulterated to any Degree, ſo that the other Part remaining for the Uſes of Ornament, &c. be of the ſame Adulteration. This is the general State of Europe, which is kept up rather above Par by this Nation, for Reaſons of ſound Policy.

By the ſame Reaſons that the current Coin ſhould be equal in Value to the Bullion, alſo ſhould each Piece of Coin be nearly equal in its intrinſic Value to what it paſſes for; and though a Guinea, when new come out of the Mint, may not be worth the Expence of recoining or clipping, yet it is eaſily melted for other Uſes; and by this Means the Nation will be deprived of the Currency, and that without any Means of Redreſs. Therefore the State of our preſent Currency is not durable, and is very liable to be varied, and give the Adminiſtration great Trouble; for ſuppoſe that all the light Gold Coin be renewed to Day, and as pure as it can be delivered out, then, from its ſuperior Value, the Gold and Silver Workers, &c. will immediately melt the ſame for the Sixpence Profit. This is evident from the intire Annihilation of Crown and Half-crown Pieces in Silver. The ſame, or a worſe Conſequence, will enſue, if the ſeveral Pieces be of much leſs Value than what they paſs for, which is evident from the State of the Silver Coin of the Nation, that we ſcarcely have one good Shilling in ten, or of thoſe coined by Government. From theſe Obſervations and Objections to the ſeveral Sorts of pure, adulterated, over-weight, and light Currency, may be concluded the real Quality and Quantity required in a regular and durable Currency.

Firſt, the Standard of the Currency and the wrought Plate ſhould be the ſame, and both of the general Value of Europe, eſpecially of the Nations immediately round us, ſuch as *France*, *Spain*, *Portugal*, *&c.*

Second, the ſeveral Pieces when new, ſhould be leſs in Value than what they paſs for, and that in Proportion to the Value of each, with an Allowance of reaſonable Wear for different Periods.

As to the firſt, I believe the Standard is pretty near what it ought to be, except in wrought Plate, which, though great Care is taken by Government to keep it with the former, yet in ſpite of all their Care, half the wrought Plate is not as good as the Standard.

The ſecond is certainly much wanted, and will preſerve our Coin the ſame, without diminiſhing or overflowing. Guineas ſhould paſs for Sixpence more than they are worth; Silver Pieces in Proportion to their reſpective Values, the ſame. The Wear of Gold ſhould be allowed as it is found from Experience, which may be called reaſonable Wear, I ſuppoſe, from Sir Iſaac Newton's Calculation on the Reigns of Kings, that eighteen Years may be allowed for the Time of each Reign: It may be ſuppoſed alſo, that three Pence will be a reaſonable Wear for that Time; conſequently every Guinea ought to paſs current that is not deficient more than three Pence for every eighteen Years from its Date, and all other Pieces in the ſame Proportion. This would cauſe each Piece to be worn while it had its Date legible, and no longer; and upon the great Wearing of each Piece, if required by Government, they might be called in at Pleaſure, without any Diſturbance to the Circulation of the general Currency.

The paſſing Value of Guineas ſhould be twenty Shillings, and then their intrinſic Value would be nineteen Shillings and Sixpence, according to the foregoing Particulars. Alſo the intermediate Pieces of Gold ſhould be *3s. 4d. 5s. 6s. 8d. 10s. 15s.* which ſhould weigh in Proportion to the Value of each and the Whole, or Guinea, of which they are Parts; the Pieces in Value above a Guinea, or golden Pound, might be Multiples of the latter, in the Manner that has been laid down before upon the Guinea.

But to avoid Fractions, and too ſmall Pieces, &c. as has been obſerved, the ſeveral Pieces of Currency would be beſt in theſe, *5s. 10s. 15s. 20s.* or the Whole; for the intermediate Pieces between one Pound and another, may be formed from ſeven Times the firſt, three Times the ſecond, or twice the third; ſuch as thirty Shillings, or one pound and a half, alſo thirty-five Shillings, or one pound and three quarters; theſe Pieces would count with Eaſe, and would readily be weighed by any the moſt ſimple Inſtruments that could be made.

Of the Hydroſtatic Weights of Gold, and how to find the ſame.

BY what has been delivered, the Reader may have an Idea of the Weights, Value, &c. of Gold in general, and of the particular Value put upon each Piece, or what it ſhould paſs for if pure when weighed in Air. Now, it is neceſſary to point out the Methods of detecting counterfeit Pieces, or thoſe which are adulterated, which muſt be come at by the Laws of Hydroſtatics, or the Weight of the ſame Pieces in Water.

The firſt Principles of Hydroſtatics, as has been ſhewn, Page 3, took their Riſe from *Archimedes*, about the Crown of King *Hiero*, and there is deduced the Rule for forming the Table of Hydroſtatics, or of the Standard for forming the Proportions uſed in finding the ſeveral different hydroſtatic Weights of different Bodies.

The Proportion for fine Gold is formed from the Difference between 19.640, and 1.000; that for ſtandard Gold, from 18.888, and 1.000 as before; alſo, in like Manner for Silver, from 10.536, and 1. The Pair formed for Standard Gold is 18.888 to 17.888. But to prevent the Trouble of Decimals, the Numbers 19 to 18 may be uſed, which will ſave a great Deal of Time, &c. Alſo, if the Silver Proportion was wanted, 10.5 to 9.5 will do very well, without the Entailment of the other Figures.

This being premiſed, I ſhall proceed to ſhew how to find the Hydroſtatic Weight of any Piece of Standard Gold: For the Proportion, ſay as 19 is to 18, ſo is the Static Weight of the Piece of Metal to its Hydroſtatic Weight.

EXAMPLE I.

What is the Hydroſtatic Weight of one Ounce of Standard Gold.

Say, as 19 is to 18, ſo is 20 to 18 Pwts. 22.73 Grains, the Anſw.

```
                 20
                ----
Wrought thus  19)360(18
                 19
                ----
                 170
                 152
                ----
                  18
                  24
                ----
                  72
                 36
                ----
              19)432(22.73
                 38
                ----
                  52
                  38
                ----
                  140
                  133
                  ----
                    70
                    57
                   ----
                    13
```

EXAMPLE II.

What is the Hydroſtatic Weight of a new Guinea, whoſe Weight in Air is 129 Grains.

Say as 19 is to 18; ſo is 129 to 122 $\frac{4}{19}$, the Anſwr. or Hydroſt. Wt.

Wrought thus,

```
      18
    ----
    1032
    .129
    ----
19)2322(122
   19
   --
    42
    38
    --
     42
     38
     --
      4
```

If this Queſtion be wrought with the Decimal Parts, or as 18.888 to 17.888, the Anſwer will come out 122.17, for the Hydroſtatic Weight, which two Concluſions ſhew the immaterial Difference of the Anſwers brought out by the two Numbers, therefore either Set may be uſed.

EXAMPLE III.

What is the Hydroſtatic Weight of a Guinea that wants 1 *s.* 6 *d.* in Air; as it wants 1 *s.* 6 *d.* at the current Value, or 2 *d.* per Grain, it is deficient in Weight 9 Grains; ſo by the foregoing Tables its Weight is 120 Grains; hence ſay,

As 19 is to 18, ſo is 120 to 113.68, the Anſw. Wrought thus. 120

```
             18
19)2160(113.68
   19
   --
    26
    19
    --
     70
     57
     --
     130
     114
     ---
      160
      152
      ---
        8
```

It is plain that the foregoing Proceſs is deduced from the Laws of Hydroſtatics, yet the ſame Concluſions for the Proportions may be come at without uſing that Property of Gold, &c. For ſince the Hydroſtatic Law is derived from the different Bulks, and the Bulks are known, without weighing the Bodies in Water, conſequently the Proportions may be known from the Bulks only. The Bulk, or Space of a cubic Inch of Gold contains 4782 Grains, and that of Water 253 of each Body, conſequently the Hydroſtatic Proportions will be as the Numbers 4782 to 4529, or as the former is to the Difference between it and the latter.

An Example.

What is the Hydroſtatic Weight of a Johannes, whoſe Weight in Air is 9 Penny-Weights 5 Grains, or 221 Grains.

Say, as 4782 is to 4529, ſo is 221 to 209 $\frac{1471}{4782}$ the Anſwer.

Wrought thus.

```
              221
             ----
             4529
            9058
           9058
           ---------
    4782)1000909(209
           9564
           -----
           44509
           43038
           -----
            1471
```

By one or other of the foregoing Methods, may the Hydroſtatic Weight of any Piece of Gold be found. But as it may be thought too troubleſome, the Table, No. I, after that of Specific Gravity, which ſhews the Value, Static, and Hydroſtatic Weight of any Piece from one Grain to 12 Ounces, at the Rate of 2 *d.* per Grain, is ready calculated for the Eaſe of thoſe who don't chuſe the Trouble. Alſo, from the ſame Methods of calculating other Tables may be conſtructed; one however ſeems neceſſary for the general Pieces now current, which is delivered under Table II.

The firſt Table increaſes by the Addition of 6 Grains, equal to one Shilling in Value, which ſhews its Uſe for any Piece of Gold of whatever Weight or Denomination it may happen to be. The Uſe of the ſecond is for current Coins, with their Subdiviſions and Multiples, placed to form a Series of Pieces that may be in Uſe as well as the preſent. To this Table is added the Difference of the Weights, for the readier knowing what Number of Grains may be uſed in Hydroſtatics for each Piece when weighed in Water; therefore if any Maſs, or current Piece of Gold upon weighing in Air and Water agrees with theſe two Tables, it may be eſtimated of pure Gold, but if lighter in Water, then the Maſs or Piece has been adulterated with ſome baſer Metal.

The foregoing Tables are in general taken from the Works of great Men, as Mr. *Roger Coats*, *Emerſon*, &c. to ſhew their Authority; but with a very deſerving Author I do not find them agree with Experiments, for he found the Water Weight of Standard Guineas to be 122 Grains, which makes the Difference 7 Grains. If the Static or Air Weight be divided by 7, it gives the Specific Gravity of Guineas, or 18.42857, which is ſomething leſs than that delivered in the Table. But by Experiments made with my Hydroſtatic Rule, hereafter explained, the Truth of which I am certain of, I have found, the Water-Weight differed ſomething more than his, or near 7 ¼ Grains, which ſhews the great Advantage to Science as well as Trade, in having accurate Inſtruments.

The ſame accurate Experiments continued upon *Portugal* Gold, give the Difference near 12 ¾ Grains for a 36 *s.* Piece of full Weight, or 9 Penny-

Weights 5 Grains, and for a Moidore 9 $\frac{4}{5}$: Hence it may be inferred, that if Guineas or their Parts, as well as Multiples, loſe no more in Water than 7 $\frac{5}{4}$ Grains, for 5 Penny-Weights 9 Grains, that they may be eſtimated as Standard Gold, and conſequently good, or paſſable.

The ſame may be ſaid of *Portugal* Pieces, if the Loſs in Water be not more than 12 $\frac{3}{4}$ Grains for 9 Penny-weights 5 Grains, or 9 $\frac{4}{5}$ for 6 and 22, the reſpective Weights of 36 *s.* and 27 *s.* Pieces.

Of the Metals of Adulteration.

THE foregoing Rules, Tables, &c. are to determine whether a Piece of Gold be adulterated or not; now the Series of our Enquiries require to know the Quantity, as well as the Sort of Metal it is adulterated with; for it is plain from the Table of Specific Gravities, that Silver, Copper, Braſs, and Tin will admit of a Deception in Gold; from their Specific Gravities, if their other Qualities will agree. Silver unites well, and is leaſt diſcerned from its Weight; but its Colour is a great Objection.

Copper has nearly the ſame Properties as well as Exceptions of the former, but that its Colour may be helped by other Metals, as will appear farther on.

Braſs and Tin can never anſwer well to any Quantity worth while for a Coiner to be hanged for, therefore they are ſeldom uſed but when compounded with other Metals. Hence it is plain, that when a Piece is deficient in Water, more than what has been noted, that ſtill it is a difficult Matter to come at the real Knowledge of the Adulteration; but every Inquirer may be greatly aſſiſted from the Theorems raiſed for this Purpoſe by Dr. *Sanderſon*, *Simpſon*, and other Algebraical Writers. The Rules drawn from the Theorems are; for a Mixture of Gold and Silver, *multiply the Hydroſtatic Weight of the Piece by* 399, *and its Static Weight by* 361; *then ſubtract the latter Product from the former, and divide the Remainder by* 17, *which will give the Grains of Gold in the Piece, and the Grains of Gold ſubtracted from the Weight of the ſame, will give thoſe of the Silver.*

EXAMPLE.

“ Suppoſe a Piece compounded of Gold and “ Silver to weigh in Air 18 Penny-Weights 10 “ Grains, or 442 Grains, and in Water 17 Penny-“ Weights 2 Grains, or 410 Grains? Quere the “ diſtinct Quantity of Gold and Silver contained “ in this Piece?

1ſt Factor is	399	2d Factor is	361
Hydroſtat. Wt.	410	Static Wt.	442
	3990		722
	1596		1444
1ſt Product	163590		1444
2d Product	159562	2d Product	159562

442 Static Wt. of Piece
17)4028(236 $\frac{16}{17}$ equal to Grs. of Gold
34 205 $\frac{1}{17}$ equal to Gr. of Silver,
62
51
118
102
16

“ By which it appears that this Pieee conſiſts of “ 236 $\frac{16}{17}$ Grains of Gold, and 205 $\frac{1}{17}$ Grains of “ Silver; ſo there is a Deficiency of 205 $\frac{1}{17}$ Grains “ of Gold, which at 2*d.* per Grain, amounts to “ 1*l.* 14*s.* 2$\frac{1}{2}$. But inſtead thereof there is ſo

" much Silver added to make up the Static Weight, " which at Half a Farthing a Grain is worth " *2s.* 1½ *d*: ſo that the Piece is only depreciated " 1 *l.* 12 *s.* 1 *d.*"

I have added the foregoing Rule and Examples for the Uſe of thoſe who want to find the Quantities of each Metal by the Pen, which is not to be done but for large Pieces, or a Maſs of Compound. I might continue the Rules and Examples for any other two, but they being foreign to our Purpoſe, I ſhall decline giving any more, but proceed to ſhew the Principles by which Pieces of Money may be detected, by weighing and comparing their Weights to Tables ready calculated.

The firſt of theſe Principles, as has been ſhewn, is to find the Deficiency of the pure, in a Sort of a worſe Quality, and then to find the Value of that Deficiency in its own Value, when compared with that of a worſe Quality.

The Deficiency has been ſhewn how to find by the Laws of Hydroſtatics when the Metal is pure, and when adulterated; ſo that the Difference may appear in each, and from thence the Deficiency: The Concluſions of the former are laid down in Tables I. and II. p. 7. and the latter by the Uſe of the ſame Tables, and that of Specific Gravity preceding them, which will be illuſtrated in the Examples, &c. of this Work.

If a clear Idea be formed of the Difference in two Metals when weighed in Water, the Value of the Deficiency will be eaſily found; for it is no more than comparing the Value of the better Metal with the Deficiency of a worſe, when they are weighed in Water, and both are of the ſame Weight in Air. Thus ſuppoſe that two Pieces, one of Gold and the other of Silver, weighed the ſame in Air, but when weighed in Water, the Water-Weight of the Silver is leſs than that of

Gold, then the Value of the Deficiency in Silver is equal to the full Value of the Gold in Air, or Water. This is evident, for if the Metals were of equal Weight in Water, then they would be of the ſame Purity, and conſequently of the ſame Value. But as they are of different Weights in Water, and of the ſame in Air, the Deficiency muſt be in Proportion to the Value of that which cauſeth it, or the purer, or more compact Metal: This is univerſal, whether the pure Metal be of a greater or leſs Value than the other. Now we may proceed to find the Value of the leaſt Deficiency poſſible, for it will be

As the Deficiency of the Whole is to its Value, ſo is any Part of the ſame to its Value. Let it be required to find the Value of a Grain deficient when Gold is adulterated with Silver. A Guinea of full Weight is 129 Grains, and its Value is 21*s.* Its Water-Weight has been found to be 122,17 Grains. Again, 129 Grains of Silver in Air weighs 116,756 Grains in Water, the Difference of the Water-Weights is 5,414, which from what goes before, will give us the firſt Pair in Proportion to find the Reſt. Hence to find the Value of one Grain of Gold deficient with Silver, ſay and work as follows.

As 5,414 Grains is to 21*s.* ſo is 1 Grain to its Value 3*s.* 10*d.* ½.

```
                21
                12
               ----
               252
                 4
               ----
5,414)1008,000(186 Farthings, or 46 ½ d.
      5414          or 3s. 10 ½ d.
      -----
      46660
      43312
      -----
       33480
       32484
       -----
         996
```

Hence it appears, that if Gold be adulterated with Silver, that the Deficiency muſt be reckoned at the Rate of 3*s.* 10*d.* ½ per Grain, and if one Grain be worth that Money, two Grains will be worth twice the Value, or 7*s.* 9*d.* and three, three Times the Value, &c. From this Proceſs the Tables of the Value of Grains were formed: But it muſt be noted that, in Table III. for the Value of the Deficiency with Silver, there muſt be an Allowance made for the Value of the Silver, if the Piece adulterated be heavy or of great Value. In like Manner is found the Value of the Deficiency when Gold is adulterated with Copper, Braſs, Tin, &c. which I ſhall farther illuſtrate by an Example in Copper. Firſt, I find the Hydroſtatic Difference, and ſhall work with the ſpecific Gravity of Halfpence.

As 8,9 is to 7,9, ſo is 129 Grains of the ſame to the Anſwer, or Water Weight of Copper.

	129
	7,9
Water Wt. of Gold	1161
is 122,17	903
114,50	8,9)10191(114,5 Water Wt.
Copper Diff. 7,67	89
	129
	89
	401
	356
	450
	455
	5

Now work for the Value as before, by ſaying, as 7,67 Grains is to 21 *s.* ſo is 1 Grain to its Value, or 2 *s.* 8 *d.* ¾.

21
12
252
4
7,67)1008,00(131 Farthings, or 32. ¾ *d*
767 or 2 *s.* 3 *d.* ¾.
2410
2301
1070
767
203

So we find the Value of the Deficiency is 2 *s.* 8 *d.* ¾ per Grain, if the Adulteration be made with Copper Halfpence, which is moſt likely to be uſed, and for that Reaſon I have calculated the Table No. IV. of Values, for Grains deficient in Copper: But if the Adulteration be made with fine Copper, then the Value of each Grain deficient will be 2 *s.* 10 *d.* which the Reader may try at his Leiſure, for the Hydroſtatic Weight will be found as 9 is to 8, ſo is 129 to 114⅔. The Difference between it and Gold will be found 7,4 Grains, equal in Value to 21 *s.* In the ſame Manner are found the Values of the Deficiency when Gold is adulterated with Braſs, Tin, &c. But it is a mere Notion to imagine that much Tin can be uſed in adulterating of Gold, for it is of ſuch an heterogeneous or diſagreeing Quality that it will not unite with other Metals without ſpoiling their Quality; therefore I have not calculated any Table for the Values of an Adulteration with Tin, but for thoſe who chuſe to have it: One Grain deficient from an Adulteration of Tin is worth about 2 *s.* and two Grains will be worth four, &c.

It muſt be admitted, that to find the exact Quantity of Metal in an adulterated Piece of any Sort is a hard Taſk, becauſe few Coiners uſe one Metal, but a Compoſition of thoſe that will anſwer their Purpoſe beſt; and as we do not know the ſpecific Gravity of the Compoſition, in conſequence we cannot find the Value of the Deficiency.

But from the ſeveral Properties of the Metals we may come pretty near; fine Copper unites with Gold well, but makes the Colour too red; Braſs makes it too white, and Silver more ſo, but unites well; which Property Braſs has not. I have been told that STELL, who was hanged in *Yorkſhire*, uſed a Compoſition of three Parts of fine Copper, two-thirds of one Part, Braſs; and the other one-third of Silver, with a very little Tin to cloſe the Grain: This Compoſition will anſwer in all the Properties but Weight, in Air and Water. In coming at the Secret of making Cockſpurs I had Occaſion to try various Compoſitions in Silver, Copper, Braſs, Tin, &c. and found, that the Hydroſtatic Weight of Silver Cockſpur Metal, as they are beſt made by Mr. *Toulmin* in the Strand, are very near that of Silver; ſo that the Compoſition will be equal to Silver for its ſpecific Gravity; but it has ſo much Arſenic in it, that the Jingle in the Coin is made too hard. The greateſt and moſt cunning Coiners that have hitherto been produced were the *Light Oulers*, one of whom pleaded his own Cauſe at *Lancaſter*, and ſaved his Life; a Part of this Man's Compoſition uſed in Coining I have ſeen and had in my Hands; but a Certainty of all its Parts I could not get hold of: However, from its Colour, Jingle and Weight, I ſuppoſed it to be near the above of STELL's, which is the moſt ingenious; and if thoſe that follow this unlawful Trade do not uſe the ſame, they muſt a worſe, which will eaſily be detected; and therefore not worth the Public's While to uſe their Inſtruments for that Purpoſe, as they may do without.

The foregoing of STELL's I think the only Compoſition, or one near it, that is difficult to be diſcovered, and therefore the only one that Attention ſhould be paid to; for this Reaſon I have given its Hydroſtatic Weight after that of Braſs in Table VI. and its Value for the Deficiency in Table VII. the reſpective Uſes of which will be ſeen in the Examples after the Deſcription of the Inſtruments to which they belong.

I might now proceed to ſhew how to find the Metals of Adulteration by the Pen, but the chief Uſe of this Treatiſe is to have good Tables, with the reſpective ſpecific Gravities, &c. marked down for each Metal of Adulteration, that when the Inſtruments have determined the Weights in Air and Water, then the Tables of Hydroſtatic Weight, and Value to each may point out the Whole, which is what I have now delivered all in one View in Pages 8 and 9. I next proceed to the Deſcriptions of the neceſſary and uſeful Inſtruments to perform with Eaſe what might take up much Time to diſcover by the Pen or common Scales with their heretofore-mentioned Improvements.

The firſt Principles of the LEVER; *with an impartial Examination into the Principles of moſt of the different Sorts of Weighing Inſtruments, &c.*

Of the LEVER.

THE Word LEVEL, or LEVER, is uſed for that Poſition of two different Bodies, when they are held in Suſpence from a Centre of Motion, that one ſhall be of equal Height from the Ground with the other. As the Word ſignifies the ſame, whether the Bodies be equal or not, conſequently it muſt convey the Idea of two different Spaces, in the Caſe of the Inequality of Bodies. Hence, when two unequal Bodies are on a Level, they muſt be at unequal Diſtances from the Centre of Motion. This Property of Nature is ſelf-evident in every Thing that we ſee moved, or is moved by us; ſo that without any Demonſtration the Property may be taken as a ſelf-evident Truth or Axiom, viz. that when any two unequal Bodies are to be held in Suſpence or upon a Level, that the Diſtances from the Centre of Motion muſt be unequal alſo, and in Proportion to the two Bodies to be ſuſpended; but that when the Bodies are joined to their Spaces to be on a Level, the great Body muſt be placed to the little Space, and the little Body to the great one. This is the firſt and moſt ſimple Idea of the Principles of the Lever, which is moſtly couched up in fine Words to the ſame Senſe, ſuch as the Quantities of Matter are reciprocal to their Diſtances from the Centre of Motion. Theſe Words carry a clear Idea to Gentlemen, or thoſe who have had a regular Education, but to others do not. The ſame may be ſaid of the different Words

Equipoiſe, *Horizontal*, uſed for the Word *Level*; the former from equal Weight, formed of two Latin Words, and the latter from the Greek, which means to be level with, or parallel to the Plane of the Horizon or Surface of the Earth; alſo the Word *Fulcrum* is uſed for the Centre of Motion, &c.

Theſe are the Principles from which Scales are made to determine the different Weights of Bodies, and by having a Standard for one Sort, all others may be compared with the ſame, in order to convey an Idea of the Worth of any Quantity of Matter, according to the agreed Price for a Quantity of Weight. Hence come the different Sorts of Weights in Proportion to the Quality of the Body to be weighed.

From the Principle of the LEVER, it is evident that two equal Bodies, to be in Equipoiſe, have equal Spaces from each to the Centre of Motion; for Spaces muſt be in Proportion to the Bodies, and the Bodies are equal; therefore the Spaces muſt be ſo. Hence it is that the Balance is choſen for the moſt univerſal Conſtruction of determining the relative Weight of Bodies to each other; for equal Weights and Spaces will produce the ſame Velocity. So that a Variation may ſoon be obſerved, and conſequently the Difference of Weight between them. But we ſhall find that the Balance is as exceptionable as any other Conſtruction of the LEVER, if there is any Miſtake in the Fulcrum or Centre of Motion, which is very liable to be ſo, if made by the moſt accurate Hands, and after the moſt approved Judgment.

Of the Fulcrum or Centre of Motion of Bodies in Equipoiſe.

THE Centre of Motion of any two Bodies in Equipoiſe, is the moſt accurate Matter to be determined poſſible, eſpecially to the working Mechanic, for it is required for him to fix it ſo that the Ballance may be affected with the leaſt Weight poſſible, and to hold its Equipoiſe by an oppoſite Effect; to obtain which, it is beſt for common Practice to have the Centre of Motion above the apparent Line, joining the Centres of Gravity of the two Bodies in Equipoiſe, and that in Proportion to the Diſtance of the Bodies, and their Quantities of Matter or Weight, which is beſt come at by Practice or Experience in different Sorts of Beams. If the Centres of Gravity could always be aſcertained in the Arms of the Beams, then the Centre of Motion would be in a right Line between them, but for fear of miſſing their Centres, and being below, the Centre of Motion is placed above, and is known in Practice by the ready and eaſy Return of the Beams; for if the Centre of Motion be below the Centres of Gravity, one Arm of the Beam will deſcend from an Equipoiſe by a little Weight, or will eaſily be affected but will not return; if in a right Line it will aſcend and deſcend for a long Time without loſing its Motion, and be ſlow; and if too high, wont be affected with a little Weight, beſides the Motion given will ſoon be loſt. Theſe different Poſitions of the Centre of Motion might be demonſtrated by Geometrical Figures, and ſome mechanical or philoſophical Expreſſions; but let it ſuffice to inform the Reader, that when the Centres of Motion between two Bodies in Equipoiſe, are in the Line joining their Centres of Gravity, then the Bodies will be eaſily affected, and will aſcend and deſcend for a long Time, or in Proportion to the Accuracy and Quantity of Matter in each.

But if the Centre of Motion be below, the deſcending Body will be increaſed in Weight in its Deſcent, as the Line joining the Line of Direction, and the Centre of Motion; alſo, if above, the deſcending Body will be decreaſed as the ſame Line; therefore, as I have ſaid, to produce a proper Equipoiſe in two Bodies, the Centre of Motion muſt be in the Line joining their Centres of Gravity, and conſequently will, in the Balance or Beam of a Pair of Scales, be much above the ſuppoſed or apparent Line of Direction, joining the Centres of Gravity. Hence comes the Reaſon that the Centre Pins of Scales are above the middle Line of the Beam, &c.

From the foregoing Principles of the Lever, and the different Poſitions of the Centre of Motion, may eaſily be gathered the ſeveral Exceptions to all Sorts of Inſtruments offered to the Public for the aſcertaining the true Weight of Gold Coin; and alſo from the ſame Principles and Errors of others, may be ſhewn the ſuperior Advantage of the ſeveral Inſtruments offered as Improvements upon all thoſe before them.

Of the deſigned Principles, general Conſtructions, and Exceptions or Errors of the ſeveral Sorts of Inſtruments hitherto offered to aſcertain the real Quantity of current Gold Coin.

THE firſt that appears, except the common Scales, are to aſcertain the Quantity and Quality of Gold Coin. The deſigned Principle of this Inſtrument is to firſt weigh the Gold in Air, and then in Water, or upon that of Hydroſtatics, and by the Loſs of Gold in Water more than the

Standard, or the Mark upon the Rule, its Purity is to be found, but by what Law the Uſers of the Inſtrument are not told, only that if the Slide-Piece comes to particular Diviſions, they muſt reckon Two-pence leſs for each, &c. &c.

But the Conſtruction of the Inſtrument by no Means can aſcertain the Quality to two Shillings, and let alone the odd Two-pences. For firſt there is but one Slide-Piece, and a very ſhort Space, to aſcertain to a Grain the Balance of the Inſtrument, and the leaſt Value that can be allowed for a loſt Grain in Water more than the Standard, muſt be two Shillings, as has been plainly ſhewn in the former Part of this Treatiſe. That the Inſtrument cannot aſcertain to one Grain is evident, for, firſt, its Length is not above ſix Inches and is very heavy, with a moving Weight of about one Penny-Weight. Hence, if the Weight acted from one End to another of the Rule or Inſtrument, it could not aſcertain to a Grain, admitting that it weighed no higher Pieces in Value than 36*s.* becauſe the whole Spaces in Eighths of an Inch won't come in that Length, admitting Room for the Fulcrum. Again, the Fulcrum, or Centre of Motion, is much below thoſe of the Centres of Gravity; therefore, from the firſt Principles of the Lever here laid down, it is plain that the Inſtrument cannot be altered, or have the Equipoiſe determined by the Force of a Grain. Laſtly, the Money is held in a Forceps or Pair of Tongs, which is to go into the Water with the Money, and to dip to a Mark which no Man alive can hold exact to. Add to this, that for the general or allowed Loſs of Weight, the Tongs are made to increaſe or decreaſe the Money End of the Rule, by being drawn out or puſhed in, But this is a Principle that is of Uſe only in a a Lever without Matter, and not in a heavy Braſs Rule badly executed, The next that is offered for Value, Accuracy, and the honoured Title of a Patent, is the *Index Balances.* I have not much to ſay either for or againſt this Inſtrument, but that it wants the horizontal Poſition required in every Conſtruction of the Lever, and other Properties of the Fulcrum and Points of Suſpenſion, and is made very near the Pattern laid down many years ſince in *Muſchenbrook*'s Syſtem of Philoſophy, wrote in *French*. Its Truth or Value depends entirely upon the Accuracy of the Workman in marking off the Diviſions, which, to Appearance ſeem to be done.

The next is the *Pencil Steelyard*, or *Lever*, to aſcertain the Weight of Gold Coin. Whoever was the firſt that thought of this Inſtrument or Contrivance, may juſtly claim it as a neat Invention; but if he had conſidered the great Advantages derived from Space, with little Matter in the ſame, he would naturally have fallen into the improved Form offered to the Public by the Writer of this Piece under the Head of Invented and improved Inſtruments, to aſcertain the true Value of Gold Coin. It is rather curious to obſerve all, or moſt of the Shops claim the Invention of this Inſtrument, and yet that not one of them could hit upon the Improvement wanted, though the Inſtrument itſelf ſhewed the ſame to the meaneſt Capacity, therefore I ſhall ſay no more of its Imperfections here, but refer the Reader to the above Head, where the Errors in its Conſtruction appear evident from the improved Form.

The Fourth that offers is the *plain Steelyard*, in different Forms and Conſtructions; the moſt approved of which are thoſe upon Ivory, with a Scale-Diſh to receive the Money in; the Weight of which, and the Shortneſs of the Lever, are ſufficient Demonſtrations of the Inſufficiency of this Inſtrument. But under the Head of Improvements, &c. above quoted, the Conſtructor will find, that the Tongs, and much leſs Diſhes with Cranks, are not near accurate enough to weigh Gold Coin with.

As to the ſeveral trifling Sorts that are made after the different Forms of the laſt Piece, and ſeem borrowed from it, they hardly deſerve the Name of any Thing but Impoſition both upon the Public and the Workman himſelf; eſpecially thoſe to have the ſeveral Pieces of Money put with their Edges to their reſpective Marks, or Numbers, &c. or to Pins: If the Inventor would be ſo kind as to inform the Publick upon the Sale of each Inſtrument, what Edge of each Piece of Money is to lie over the Diviſion of its Weight, they might be more certain of telling the Deficiency to 6*d.* or 7*d.* at the moſt in 10*s.* 6d.

Having now conſidered the Imperfections of the ſeveral Pieces of Mechaniſm before me, and ſhewn ſome of their Errors, I ſhall now proceed to the Principles required in thoſe of Improvement, which will naturally ſhew their Superiority over, as well as the farther Errors of the former Attempts only, for the deſigned Purpoſes.

Of the Principles and neceſſary Conſtructions of accurate and improved Weighing Inſtruments.

THE firſt Conſtruction that is made up from the Principles of the LEVER, and for our preſent Uſe, is the Balance or Scales.—From the foregoing Properties of Matter, it is evident that every Particle of Matter in the Beam muſt be in Proportion to its Diſtance from the Centre of Motion, not only of thoſe in a Right Line joining the Centres, but of thoſe out of the ſaid Line; therefore it is neceſſary that each Arm be exactly ſimilar and equal Solids, or of the ſame Length, Shape and Weight; conſequently there is to be no more Elbows, Cranks, or Irregularities, in one more than there is in the other; or if one be regular and well filed and the other not, then the Beam will be uſeleſs, at leaſt not correct. To come as near this Form as poſſible, every Beam ought to be no heavier than what will be of a ſufficient Strength to ſuſpend the Bodies to be weighed. To maintain the foregoing Properties, it muſt be neceſſary for the *Fulcrum*, or Centre of Motion, to be in the Point that terminates the proportionate Diſtances, or in the Middle between the two Points of Suſpenſion, as well as in the Line joining them. The foregoing alſo require, that the Points of Suſpenſion and Centre of Motion be always the ſame, or that if the Beam varies its Poſition from horizontal, that theſe three Points keep the ſame Diſtances. Hence then the Centre of Motion ſhould be upon the leaſt Point poſſible, or upon a Knife Edge; and the two Points of Suſpenſion ſhould be either very ſmall and drilled croſs the Beam, or large and drilled in the Length of the ſame; the former Method is advantageous for Conciſeneſs, and the latter for mathematical Accuracy, either of which will perform, if done with the Head and Hands of a Workman. The leaſt Friction of two Bodies in Contact is in thoſe that one rolls upon the other, or a rolling Body upon a right Line has the leaſt of any. Hence if the Frame of a Pair of Scales has the Bottoms of the *Fulcrum* Holes a right Line, or filed ſquare, and the *Fulcrum* has Cylinder Pivots, theſe two would have the leaſt Friction poſſible. The Objection to this Conſtruction is, that the Arms will increaſe and decreaſe in Length in Proportion to the Diameters of the Pivots; but all Objections are removed if the Bottom of the Holes be near a right Line, and the Edges of the Pivots not perfect Edges, but firſt made ſharp, and then burniſhed, which will cauſe a ſufficient Bluntneſs or rolling Edge. The Index Pin ſhould be long, for the Advantage of readily diſtinguiſhing the Equipoiſe of the Beam. But on the Reverſe, it adds to the Weight of the deſcending Arm, and conſequently cauſes the *Fulcrum* to be above the Points of Suſpenſion, which is a greater Diſadvantage than any one that can be removed by its being long. From the Properties of rolling Bodies one upon another, the greateſt Freedom in Suſpenſion is gained by round Wires, and the Holes of the Beam as common, if done with Judgment. From the Experiments that I have made, and delivered under the Deſcription of the Slide Rule, the Freedom of Suſpenſion is one of the greateſt Matters required in Weighing Inſtruments, and from thence it will be found that the Diſhes ſhould be in the Form of a concave Cone, that the Weight of each Piece may cauſe it to deſcend to the Middle of the Diſh.

From theſe general Obſervations every working Mechanic may judge of the proper Conſtruction of a good Beam and Scales; as well as the common People may judge for themſelves of their Goodneſs, and if wrong, may eaſily mend them, or correct the many trumpery Stuff that are offered as perfect.

Many in Mathematical Inſtrument-Makers Shops will boaſt to the ignorant that any particular Inſtrument is good becauſe when put in Motion it will vibrate a long Time. But ſuch an Inſtrument may have its Centre of Motion too high, and cauſe the Matter in Equipoiſe to become as a Pendulum, therefore will vibrate as long as the Conſtructor pleaſes to make it. Others again boaſt that their Inſtruments will turn with the leaſt Matter poſſible; but if the Centre of Motion be below the Points of Suſpenſion, and the Inſtrument be near an Equipoiſe, then a ſmall Weight will turn one End and have no Effect upon the other; or if the Weight be put into either, and get the leaſt Aſcendency

dency, it will maintain it, and cauſe a quick and ſenſible Motion, when the Inſtrument itſelf has no Accuracy in it.

Therefore firſt to judge of a Pair of Scales, put unequal Weights, but the leaſt poſſible, into the Diſhes, and obſerve the Difference made, which done, change the Weights, and if the Difference be the ſame in the Change as before, the Arms are of an equal Length. Again, when equal Weights are in Equipoiſe, or the Scales alone, put them in Motion, and if they vibrate long and quick, the Centre Pin, or *Fulcrum*, is too high; and if one fall down when it has got the Aſcendancy, or either will be too heavy, then the Pin is too low.

Mechanicks know well enough how to cure thoſe Scales that have their *Fulcrum* wrong placed, but common People do not know ſo well; if they obſerve the following Rules they may correct Scales when out of Order, or of thoſe made by ignorant Pretenders.

If the Beam is found to have unequal Arms, then they may be made equal by bending in, or opening out, the Arches at the End of the Arms: If the *Fulcrum* be too high, ſet up the Arms cloſe at the Centre, or as near to it as can be got, and if too low, likewiſe bend the Arms down at the ſame Place. To know how far they may be ſet up or put down, or more properly to adjuſt the *Fulcrum*, let the Scales be equipoiſed with about five Penny-Weights, and put one Grain into one End, which when the Scales are well adjuſted, will bring the Index to Half a right Angle, or in the Middle of the Space between the Index and Beam, when they are in Equipoiſe: This will be an univerſal Rule for the common Lengths, &c. The ſame otherwiſe, when the Beam is found to have the Arms equal, and when equal Weights are in, about five Penny-Weights each, if a Grain does not move the Index through the above Space, the *Fulcrum* is too high, and if more, then it is too low. The Publick may depend upon this as a Rule to adjuſt their Scales by, if they have any Sort of Execution in them, but it may be poſſible, in the Multitude that have been made, that not above one in a Hundred will move at all with the *Fulcrum* either high or low, but moſt likely the latter Sort may.

From theſe Rules, &c. may be judged of the great Accuracy required in Scales, and how little they have been attended to by thoſe even that offer them as perfect. I have found that ſome of the moſt accurate Hands in Execution as well as Judgment, have not been adequate to the Nicety required in ſuch Inſtruments.

All the Work that appears like Iron, that is the Beam, Frame, &c. ought to be made of Steel, and the Beam in particular of that Metal, and hardened to a Spring Temper, that it may contain little Matter, and be of ſufficient Strength to ſuſpend the greateſt Piece ever weighed. When a Pair are thus made, they will be found much ſtronger, and of one Half the Metal put in thoſe commonly offered to Sale. The Diſhes ſhould, as has been obſerved, be conical and poliſhed ſmooth within, that the Pieces may incline to the Middle for a free Suſpenſion; a Matter not much noticed by any one, but which will appear neceſſary in the Conſtruction of the Slide Rule, which here follows after the Deſcription of the Hydroſtatic Weights, &c.

The Principles and Uſe of the Hydroſtatic Hair-Purſe and Weights for the Uſe of common Scales, &c.

THE great Imperfections of any Inſtruments heretofore made for aſcertaining the Quality of Gold Coin, as well as its Weight, induced the Inventor of the next Article, or Slide Rule, to adapt ſomething for common Scales for the Sake of thoſe who would rather truſt to Scales than any other Contrivance of the Steel-Yard.

As it has been obſerved that Tongs for holding of Money may do in Air, but for the ſame to be uſed in Water requires that ſome Deductions be made for the Immerſion of the Tongs along with the Gold; and though this may be done, it is unſatisfactory as well as unpracticable to hold the Veſſel with the Water to the Mark upon the Tongs or Wire, eſpecially by the Generality of People, who cannot hold it to a Grain, which muſt be done as appears from p. 29, 30, 31 and 32 of this Treatiſe, if they intend to tell the Quality to 2*s.* 6*d.* at leaſt.

The Hair-Purſe is made of a ſingle Horſe-Hair, and is ſufficiently ſtrong for any Piece that ever paſſes current now. Nay I have choſe thoſe that are ſmall and genteel, as one too ſtrong I have found to make a Variation of nearly ¼ of a Grain from its Bulk only.

The Weights to be uſed are made from p. 26, or Table II. of this Work by real Experiments with the Hair Purſe; and as ſeveral of them require to be aſcertained to $\frac{1}{16}$ of a Grain, great Care is taken to do the ſame with the Slide-Rule hereafter deſcribed; without which Inſtrument it would have been impoſſible to have made them: Their Uſe muſt be evident from what has been delivered in this Treatiſe, and what follows in the Examples to each Inſtrument.

Thoſe who purchaſe new Scales ought to have a little Hole through each Diſh, for the Uſe of the Purſe, and it would be beſt to have the looped Hair to its Top ſingle, for the Sake of a certain and free Suſpenſion, eſpecially in light Pieces, ſuch as 4*s.* 6*d.* &c. which hardly will ſtretch a double Hair.

Alſo in ſuch Scales there ſhould be an arch Piece divided into equal Parts, at leaſt to meaſure Half a right Angle from the Line of Suſpenſion, by which Means upon Trial of any Piece, a Grain Weight might be put into the Diſh, and then would appear by the Index, the Motion of the Scales, how far it moved for the Grain, and by the Subdiviſion of the Arch Piece would be known the Parts of a Grain in any Pieces tried. This Arch would only be of Uſe when the ſmall Weights were miſlaid or loſt, &c.—Or for thoſe who have them not, or would rather know the Parts from Trial than truſt to other Inſtruments for their Accuracy, &c.

Of ſeveral improved Conſtructions of the LEVER, *or* STEEL-YARD.

WE have ſeen from what has been delivered, the Concluſions and Conſtructions required, and Exceptions that may be made to the Balance or equal armed *Lever:* Now it is proper to conſider thoſe Conſtructions when the Arms are unequal, or ſuch as go under the Name of *Steel-Yards.*

In the Balance, or common Scales, each different Body muſt have a different Quantity of Matter or Weight; ſo that to come anyways near general, and let alone univerſal, it is required to have an infinite Number of Weights, which are attended with their Conſequences that are in nowiſe agreeable.

The Steel-Yard removes this Inconveniency, but has its oppoſite Exceptions, unleſs done with great Accuracy. For in this Inſtrument there is only one Weight which acts conſtant for all intermediate Pieces from the greateſt to the leaſt Piece uſed; conſequently, the intermediate Parts muſt be ſhewn by Spaces, which is the concomitant Attendant to Matter for the forming an Equipoiſe to different Bodies. Any Inſtrument that holds an Equipoiſe, and has its Arms unequal, is a Steel-Yard, no Matter in what Form, or by what Name it may be called, conſequently as the Arms may be ſo various, and the Methods of Suſpenſion, &c. Steel-Yards are, or may have the ſame Variety; ſo that it muſt be difficult for the Publick to determine upon the beſt, or thoſe that are uſeful only.

The firſt Conſideration in theſe Inſtruments is, to have Space, that the Diviſions may be diſtinct and eaſy to be underſtood, or conſpicuous. Then it is neceſſary that the Space ſhould have the leaſt Quantity of Matter poſſible in it; for if the Space or Diſtance be long, and the Matter heavy in Proportion, the Conſtruction is only a Burthen or a Multiple of a leſſer one. Hence it is proper to have the ſeveral Conſtructions of the lighteſt Material, ſo that they may anſwer all the Properties required in them: therefore Box Wood is better than Braſs or Ivory, but has its Exception of Bulk.

The next Conſideration is, to have all the Appendages or Parts in Uſe, that no unneceſſary Labour may be thrown away, and alſo to have the whole Inſtrument portable as far as neceſſary and no farther; for to make one unneceſſarily compact is as great an Extream as not making them at all ſo.

The Conſideration of Space, and little Matter in the ſame, points out that the Beam or Lever muſt be made in the Solid that contains the leaſt Matter. Hence a flat Piece, or the ſame rolled up, offers as the beſt; the former for Conſpicuity, and the latter for Portability.

From the Conſideration of Space and Portability we are ſhewn to Joint or Slide Pieces. But which of theſe Conſtructions are beſt? If the Thought of no uſeleſs Part be attended to, the latter comes in; for the opening and ſhutting are of no Uſe in the Principles of the Inſtrument, unleſs we weighed by Angles of Space; therefore from the whole Conſideration of the Properties of the *Lever*, the Advantages accruing from an univerſal Inſtrument in weighing of Gold, and the Forms neceſſary for every Advantage required of Space, Portability, Conſpicuity and Accuracy in Performance of its Uſe, we are ſhewn to the following ſimple Conſtruction.

Six Inches long being no Incumbrance for Portability, therefore that ſhould be our firſt Limit, which we will ſuppoſe and fix on for the ſhorteſt Inſtrument that ought to be uſed. Now to gain Space, we may take twice or thrice, &c. that Space, either with a ſliding Conſtruction or a Joint, and ſtill have the ſame Length for Carriage, &c. But the former being certainly better, as will appear, I will ſuppoſe the ſame here. Hence if a flat Piece of Braſs of ſix Inches long be ſlit down the Middle near to one End, and the other made faſt by a croſs Piece of the ſame Metal, ſo that the Edges may be parallel and ſloped to receive a Dove-Tail Piece, then the Dove-Tail Piece muſt be fitted into the ſame, ſo as to ſlide without Starts or Jerks. The Size of the Slit or Dove-Tail is about one-third of the Rule, that the Sliding-Piece may bear ſome Proportion to the Weight and Space required; if it be heavy, then the Length of the Rule is loſt, and if light, the Space will be too ſhort for the Pieces required: But if the Whole be about $\frac{1}{12}$ of an Inch in Thickneſs, Half an Inch broad, and the Dove-tail $\frac{1}{3}$ of the Breadth, or $\frac{1}{3}$ of $\frac{1}{2}$, or $\frac{1}{6}$ of an Inch, the whole Conſtruction will anſwer the Purpoſe required. For, firſt, the Space in Uſe will be about 12 or 13 Inches, the Slide-Piece will be the greateſt Weight; and a ſmall one of about three Grains, which moves upon it, will ſhew Subdiviſions of the leaſt of theſe given by the other; ſo that an Inſtrument upon this Conſtruction will work in the Form of Pounds, Shillings, Pence, and Farthings.

The above is the general Deſcription of the Inſtrument as I now make it, and from the Experiments that I have made with it upon common Principles, I have been able to come at the real Errors that are but too common in Balance Inſtruments, which chiefly are to be obſerved in the Centre of Motion, or Fulcrum, and the Points of Suſpenſion of the Bodies ſuſpended. I dont ſuppoſe that it was ever dreamt of, that a ſuſpended Body would be of different Weights by being put on one Side of the Points of Suſpenſion, though the Strings, &c. or Power of Connection between them, may be the moſt pliable.

This, I ſay, is perhaps what wont be expected, but let the curious try with this Inſtrument, and it will be found that a free Suſpenſion is one of the only and chief Matters to be attended to in Equipoiſe Inſtruments. I have tried, and found that a Silk String, or ſingle Horſe-Hair, are not tender enough, nor yet a Scale-Diſh, without great Care is taken in fixing them on.

To thoſe that are doubtful in this Matter, let them put a 36 Shilling piece into a Hair-Purſe or Scale-Diſh, and let the Inſtrument be of that Sort that has the Diſh ſuſpended through a Hole; when the Piece is brought to an equipoiſe, twiſt the Hair or String round, and the Weight will vary as the Piece is in or out of the Centre of Suſpenſion:

conſequently, no String, Hair, &c. is perfectly free, and much leſs a crank Diſh. The firſt that I made were of this Conſtruction, but found them not quite accurate; and I alſo here declare to thoſe that were Purchaſers of that Sort, that they may have them altered to a more accurate Form, with a Diſh, for a ſmall Expence, if they chuſe, though the Inſtruments may not vary at the moſt above half a Grain, yet that is a great deal for an hydroſtatic Inſtrument, for which Uſe this Inſtrument was chiefly invented.

I likewiſe have made the ſame Experiments upon the Height of the Fulcrum, and from thence drew the Obſervations I have laid down upon the proving of common Scales.

The moſt approved Form now made, drawn from the Obſervations of the moſt accurate of the Public, is that with a common Scale-diſh, and ſuſpended as common, with the Plane of its Ring parallel to the Length of the Rule, and the lower Edge of the Fulcrum in a Line with the Middle of the Braſs; the Purſe is uſed by being ſuſpended through the Hole in the Middle of the Diſh. As the Rule has two Sides divided from each other by the Slide, it was natural to apply one Side to Air, and the other to Water, with a double Index upon the Slider. This is done by dividing each Side into the Pieces of Money according to their reſpective Weights and Values, with Subdiviſions of Wholes for Shillings, Halves for Sixpences, and Quarters for Threepences; the Slide-Piece is divided into Parts of 1, 2, 3, 4, &c. for Grains, according to the Weight upon it; therefore the little Weight will ſhew, by one whole Diviſion, to 2 *d.* and half to 1 *d.* &c. to one thirtieth Part of a Grain. Hence, when the Rule is uſed in Hydroſtatics, the little Weight comes of great Uſe, for then the true Weight muſt be known to one thirtieth Part of a

Grain, or the Inſtrument is of no Uſe. When this Rule is compared with other equipoiſe Inſtruments that have been offered the Public for the ſame Uſe, the Whole of its Conſtruction will appear evident; for in the only one that has been offered, as has been noticed upon, is to have general Diviſions. But by this Rule I here offer as beſt, I have found that no Part of it can be divided general, but that each muſt be ſubdivided according to the Metal in the very Diviſion required. Hence I have found, that a general Deduction, ſuch as by a Bolt, or Slide-piece, to move in and out for Air and Water, for all Sorts of Pieces, can by no Means be allowed; ſince in this Rule of mine, any one may obſerve from the Diviſions, that equal Values have not the ſame Spaces on different Sides of the Rule; hence each Piece requires its own Diviſions at the Place of its Weight.

The Slide-piece is entirely for the Uſe of Hydroſtatics; and as being the Weight or Equipoiſe of the Inſtrument, I have found that the moſt ſlight Poliſh varies its Uſe; conſequently, every Poſſeſſor or Uſer muſt be careful not to alter the Slide-Piece, or little Weight, and alſo to take Care of loſing the latter; for if either happen, there is no correcting of the Inſtrument, but by the Inventor, who may not always be at hand to perform that Office.

It is, and may well be objected in any Proceſs that is performed, to come at a ſecret Law or Receſs of Nature, that the Inſtrument or Performance is too difficult for common Uſe, or will ſoon be out of Order, &c. &c. Every Man of real Experiments, muſt know that all manual Operations for the Uſe of Science, muſt be adequate to the Delicacy of the Inquiry; and as ſuch, each Performance will be tender in Proportion to the Accuracy required. This, I ſay, muſt be admitted; for if the Inſtruments are not accurate, and difficult to be made equal to what is required of them, the different Reſearches of Nature would be equal, and would admit of no Superiority; conſequently, would leave Room for the *ill-natured Grumbler* to find Fault ſtill, by ſaying, that each well-performed Operation was no more than what was done by every one; therefore every Objector is anſwered, that the foregoing Rule is adequate to what is required of it. And I dont know how we can come at the Concluſions it brings out, unleſs by the ſame mechanical Contrivance, amended if poſſible, or by a real Separation of the Metals by eſſaying. As to its being too nice and critical, or indeterminate to thoſe of a weak Underſtanding, I anſwer, that it muſt be ſo, or not at all adequate to what it is offered for. Of what Uſe is it to have an Inſtrument coarſe and ill-executed, without Principle? It is true, the Diviſions of deſigned Accuracy may be put on, but if the Performance has not a firſt Principle to anſwer, the ſecond, or any other in conſequence, cannot; this is evident in the Nature of all Sorts of mechanical Performances whatever, but appears in no Sort more evident than in Watches, in which ſeveral of the Conſtructors take great Pains, and go to great Expences to have an accurate Dial divided into Seconds, &c. when the Principle of the Machine is not adequate to three hundred Times the Accuracy required. This muſt be beginning at the wrong End, and upon which Rock I have often ſplit myſelf.

I thought proper to premiſe the foregoing Obſervations, to account for ſeveral ſingular, and may be thought uſeleſs Properties, that I have adopted in my Plans of Inſtruments, and particularly in this Rule; as firſt, admit that every Hand was ſteady, and could hold up an Inſtrument conſtantly the ſame; yet it is impoſſible for the ſame Perſon to obſerve, compare, and calculate for Hydroſtatics, at the ſame Time, at leaſt for the Accuracy required in ſuch an Inſtrument. We are not here to gueſs to two or three Grains, as is common; for ſince, as it has been ſhewn, that each Grain deficient in Water is worth at leaſt 2 *s.* 6 *d.* conſequently, two or three Grains muſt make a great Variation.

Hence I have choſe long Scales or Radius's, and Supports, as much as poſſible, inſtead of Suſpenſions, that the Hands may be free to ſteady the Inſtruments, and ſee the Diviſions with Eaſe and Perſpicuity, &c. and alſo to have all the Parts uſeful. The farther Uſe of this Inſtrument will appear in the Examples to each Sort after their Deſcriptions and Explanations, &c.

The next Inſtrument that follows in Order, is the Pencil Steelyard, the firſt Thought of which, as has been obſerved, was worthy of Improvement, and which I have taken ſome Pains with to bring to Perfection, for the Uſe of thoſe Gentlemen who delight in every Advantage almoſt that can be expected from ſuch an Inſtrument. It is the Slide-Rule in a different Form, or rather more compact, and better for every Thing required, except the hydroſtatic Part, which could not well be applied without falling into the ſame Errors of thoſe before me, of leaving moſt of its Uſe to gueſſing. The firſt Conſtruction is with a ſolid Piece of Braſs to ſlide into a Tube, and by being moved in or out, the different Pieces of Money are determined, by the Tube being moved out for the heavy Pieces, and in for the ſmall ones; the latter of which puts the Inſtrument very near into the Form it is in when put into its Caſe. It is about five Inches long, and about one-fourth of an Inch in the Diameter of the outer Tube. The Braſs Piece is ſlit down the Middle, about half the Length, to hold the Tongs and Suſpenſion-Piece; the Figures to ſhew the Diviſions of each Piece of Money, are put on the ſolid Braſs Piece. This is the Whole of the Conſtruction of the firſt Thought of this Inſtrument, which, if compared with the Principles laid down in treating upon the laſt Article, as neceſſary in every Performance of this Sort, its Inſufficiency muſt appear, as well as the great Room for improving it. For, firſt, a Tube may be made extremely light, and to anſwer all other Exceptions that may be raiſed to the Lightneſs of other Inſtruments: Again, in the Place of the ſolid Braſs Piece may be put two Tubes or more, which will draw out to a great Length, and have very little Matter in them, the very Property required.

After conſidering the whole Conſtruction, to make it the moſt ſimple and yet uſeful Inſtrument, and alſo to make it compact, accurate in its Determinations, as well as eaſy in uſing, I came into the following Form; I make it about five Inches long when put together, conſiſting of four Pieces that ſlide in each other, the outermoſt of which is the Caſe, which is alſo cut into two Parts, one of which Parts is for the Stand to ſupport the Inſtrument when in Equipoiſe, and the other is for the Tongs to hold the Money in Suſpenſion; theſe two being fixed to their Uſe, the other three Pieces that ſlide in each other, are drawn out, and then form a Steelyard of about fifteen Inches in Length; conſequently each Piece of Money will have ſufficient Space to produce diſtinct Diviſions and Conſpicuity in Weighing. The ſeveral Pieces are marked upon the middle Slide-Piece or Tube, and upon the ſmalleſt Piece, or Wire, is a ſmall Weight for Subdiviſions of the leaſt Diviſion of the middle Tube; this Weight being moved along the Diviſions on the outermoſt Piece, varies the Equipoiſe one Grain for each Figure, 1, 2, 3, &c. The whole Diviſions upon the Money Tube below or between each Piece, are Shillings, and each Subdiviſion, Sixpences; and as the little ſmall Weight varies the Equipoiſe a Grain for each of the Diviſions marked 1, 2, &c. conſequently, for each Grain moved, it ſhews the Value to two Pence, and for Half, one Penny, a Quarter, one Halfpenny, &c. to the moſt minute Parts poſſible.—Two little Pins are put into the Sides of the outer Tube for Pivots or the *Fulcrum*, which work or move in the Notches of the Top of the Caſe or Stand.

If the Hydroſtatic Diviſions could be put on without creating Confuſion, I know not but this Inſtrument would be ſuperior to the former, for it has all the Excellency in it that can be expected, and is equal to any other for Cheapneſs, when its ſuperior Uſes are noted.

I do not know whether it may not be worth while to obſerve, that if the whole Length, when put together, could be thought portable, about 6 ½ Inches in Length, that then the Whole, when drawn out, would be a two-foot Rule, with Inches and Parts upon one Side, and when it is put up it is a compleat Tobacco-Stopper; which would be three little Eſſentials neceſſary in ſuch an Inſtrument, that would come in Uſe with moſt Gentlemen, and many Tradeſmen.

The next Contrivance that I offer, as curious and uſeful, is, the Dial Steel Yard, for the chief Uſe of Ladies and Gentlemen only: This little Inſtrument is in Length only about 3 ½ Inches, and weighs very light; it is made in various Forms to ſuit different Fancies; but the moſt general and uſeful I have determined to be of the following Conſtruction.

The whole Machine is in the Form of, and is ſuſpended like a Pair of Scales, but having only one Arm and Diſh to put the Money in, as well as one Weight, it is rendered much more commodious than the Scales and Weights. The Arm Piece is to the right, and the Diſh to the left Hand; upon the former are marked the ſeveral Diviſions or Places where the Weight muſt be moved to when the Pieces, from one Guinea downwards, are of full Weight, and below each Piece of the Money Diviſions are leſſer ones for Shillings, and Halves for Sixpences. Alſo Diviſions for Sixpences, or lower, are marked upon the Enamel Dial-Plate. The Dial is divided into four equal Parts marked with the uſual Figures 1, 2, 3, 4, each Diviſion or Quarter of the Dial is 1 *s.* Half 6 *d.* a Quarter 3 *d.* and the outmoſt or leaſt Diviſions are Pennies.

The Principle and Uſe of the Inſtrument conſiſts in the Lever or Arm being lengthened or ſhortened by the moving of the Hand on the Dial from one Diviſion to another; ſo that when the Weight of any Piece of Money is determined to 6 *d.* upon the Arm Piece, the minuter Parts may be known to 1 *d.* or leſs by the Hand upon the Dial. To determine the Equipoiſe, there are two Pins that come into a Line for Pieces of full Weight, and not ſo when they vary, or are light. The Pins are ſeen through a ſquare Hole made in the Frame that ſuſpends the whole Machine. As I have proved that Suſpenſions are not ſo ready, accurate, nor ſo conſpicuous as Supports, this Inſtrument will ſhew the ſame, for the Equipoiſe Pins will move from each other to the Value of 3 *d.* when the beſt Eyes in the World cannot diſtinguiſh any Variation in the horizontal Poſition of the Beam or Arm Piece; conſequently this proves the Inaccuracy of thoſe Inſtruments that have the Freedom of their Motion and exact Determinations to be known by the Eye only.

The Hand upon the Dial is fixed upon a Pinion that moves the Beam, and when it is moved towards Figure 3, it ſhortens the Arm Piece or Beam, and makes the Piece of Money lighter than is ſhewn by the Weight; or when the Hand is moved towards Figure 8, the Diviſions ſhewn by it are to be ſubtracted from the Weight ſhewn upon the Beam, and when it is moved towards Figure 1, the Diviſions ſhewn by it are to be added, or taken away from the Weight ſhewn upon the Arm Piece or Beam: The Increaſe or Decreaſe of the Figures point this Matter out. See the Examples.

The Inſtrument that comes next in Order, and which deſerves to be deſcribed as one of the firſt, is that which is called the Weighing Rule. It has the Properties of Space, a ſmall Quantity of Matter in the ſame, which are the two great Eſſentials required in all Weighing Inſtruments; it deſerves the Title of an Invention, but being the Production of a young Gentleman who has too great Modeſty to admit that the Inſtrument ſhould have its *real Name*; it is only called an Improvement: However, it is the firſt that was ſeen with a Support inſtead of a Suſpenſion, and, from the Compariſon I made with it, and the Exceptions to Inſtruments with Suſpenſions, I have compleated all the reſt of mine upon the ſame Plan. The particular Conſtruction of it, is, that it is about a Foot long when in Uſe, opens with a Joint, and is divided into 24 equal Parts, which it will admit of to be Spaces of equal Values from the Levity of its Matter being made of Box Wood; therefore whatever is the weighing Value of one Space at one Part of the Rule, the ſame Space will be the ſame Value at another, which is the great Exception to Inſtruments made of Metal; ſo that if the Value of a Space be truly determined in any one Part of the Rule, the ſame Space in any other Part will be the ſame Value, and conſequently gives a greater Certainty of the Inſtrument being juſt in all its Parts. This is a Matter that ought to be well noticed by all Purchaſers of Gold Inſtruments, for in thoſe that are made of Braſs, &c. it may be poſſible for a Space in one Part to be equal to a Shilling in Value, and not ſo in another, becauſe the Matter in each Space not being inverſely as the Diſtances, the Values will not be ſo likewiſe. Hence it is, that Braſs Inſtruments require the Diviſions to be made by Trial, and if not done with great Care, may cauſe great Errors. From hence the Public may determine another great Matter required in Weighing Inſtruments, *viz.* that if they be heavy, or are made of heavy Materials, that they have not one of the great Properties required in them; and if other Cauſes could be removed, that thoſe made of Box are better than thoſe of Ivory, Braſs, &c. and if ſo in the different Sorts according to the Weight of the Materials, the ſame may be ſaid of thoſe that have a leſs Quantity of the ſame Materials in them than of thoſe that have more. A more particular Deſcription of this Inſtrument will appear in its Bill of Directions, by the Maker Mr. *Adams*, and in the Examples to all of them hereafter given.

The laſt Conſtruction that comes in Courſe, is one of that Sort which may be called an univerſal Steel-Yard. It has a fixed Arm Piece oppoſite the Lever, which is divided into a Line of equal Parts and Values, each whole Diviſion being about Half an Inch for the Weight of one Penny-Weight, at the Rate of 4*s.* per Pwt. ſo Half will be 2*s.* and a Quarter, 1*s.* &c. At the out End there is an Arch which gives the Sub-Diviſions of the leaſt upon the Radius or Line of equal Parts; and to come as near the Principles of the laſt Inſtruments as poſſible, the Lever is made of Steel, and both very hard and ſmall, that the Weight which moves upon it may always give the ſame of the Diviſions of equal Values upon the Arm Piece. The Whole is fixed to a Stand for the Uſe of Counting-Houſes, Shops, &c. I have made it of various Forms, but the moſt univerſal is to have three Weights, one of ſix Grains, one of one Penny-Weight, and one of four: By theſe three Weights all Pieces or Sums of any Value from 4*s*. to 10*l*. (both incluſive) may be determined, and for the Diſpatch of Buſineſs is put to, if required, a Braſs grooved Piece, to cauſe the ſeveral Pieces of Money to run down into the Scale Diſh, and by that Means may be known whether Guineas be paſſable or not, by only fixing the Weight to 20, and letting them run down one after another as faſt as they can be taken out of the Hand. But this Contrivance is only put to thoſe that are beſpoke, as being but ſeldom wanted, and cauſing the Inſtrument to come dear.

I own that the laſt Inſtrument has not the ſame Accuracy of Principle in it that thoſe before it can boaſt of. However, it is offered as equal to moſt of the ſame Sort, eſpecially the Index Balances, having one ſuperior Property to the latter, and is equal to it in all others, which is, that it has the horizontal Poſition of the Lever, a Property that *Muſchenbrook*, the firſt who thought of or laid down its Principles, neglected, though without ever dreaming (I imagine) that ſome ſucceeding Pretender would take his imperfect Propoſal, and make it into a Patent Balance. But this is one of the many Abuſes that is made of the Indulgence of a great and well-governed State, not only to rob in Defiance of Honour, Juſtice, and every Principle of Virtue, that are the Characteriſtics of Men of real Genius, but alſo to ſubvert and reverſe the very Law that ſecures Property to thoſe it really belongs to. This Species of Robbery is ſo frequent, that we ſeldom ſee Men who have given the

World an Improvement or Invention to reap the Benefit of the ſame, but like the diligent Bee they are deprived of their Labour by ſome over-fed and burthenſome Drone, that is the reverſe of every Idea of a Human Being, but none ſo evident as the having their Heads in their Pockets.

The other Inſtruments for the weighing of Gold that I offer next, are of various Sorts, invented for the Sake of Cheapneſs, Conveniency, &c. and are upon that Account not given as perfect, but equal, if not ſuperior to the many Trifles that have appeared under different Forms and Names.

The firſt and moſt ſimple are the Box-Rules that have a moving *Fulcrum*, and a Weight which gives a Sub-Diviſion to the Spaces of thoſe given by moving the *Fulcrum*; upon this Principle may be made either flat Rules or triangular ones, both of which I have done, to pleaſe different Fancies, and each in Box and Braſs; but the latter are the worſt Sort, becauſe of the Quantity of Matter in the Spaces, which cauſes the Diviſions to be ſo little that they are imperceptible. Theſe are offered entirely for Cheapneſs, and are not to be uſed for any other Sort of Coin, but thoſe that are not above the Proportion of one Shilling deficient in a Guinea: They are of Uſe only to the loweſt Claſs of the People, for whoſe Benefit they are made.

The next in Value and Principle is a more ſimple Conſtruction of the Hydroſtatic Rule explained before; but its Imperfection is in having the *Fulcrum* or Centre of Motion below the Centre of Gravity; it is only for the Static Weight, and will anſwer all the Purpoſes required in giving the ſame. Its Conſtruction is ſuperior, though made for Air only, to the firſt Patent Rule, which was made for Hydroſtatics upon the ſame erroneous Principles of this: They are made in different Forms to anſwer the Purpoſes or Choice of different

Ideas, or to ſuit the Convenience of the ſeveral Sorts of Purchaſers.

The laſt Thought that may be uſeful, is to turn the Inſtruments of different Tradeſmen into the Property of Gold weighing, that they need not be at the Trouble of having a Multiplicity of Inſtruments about them; but in particular the Carpenters two-foot Rule admits of an eaſy Improvement in this Matter, which I have contrived in the moſt ſimple Manner poſſible, for the Sake of all thoſe who uſe that Inſtrument as a Tool in their ſeveral Occupations. The particular Conſtruction is given along with the Rule when purchaſed, as not being worth while to ſwell this Tract with the Explanation. So far however may be obſerved, that the Joint is the Centre of Motion or *Fulcrum.* When the Rule is put in Uſe, it may be put upon a Table or any other flat Surface, and by drawing out the Slide Piece, the different Equipoiſes are come at for the various Pieces of Money.

Having now gone through the common Conſtruction of Scales, and alſo the moſt general Plans and improved Conſtructions of the Steel-Yard, the Public may have an Idea from each Deſcription, which they would chuſe as beſt for Accuracy, Portability, &c. But as the greateſt Part of thoſe that have Occaſion for Weighing Inſtruments, incline moſt for Scales, and would uſe no other if they could be made portable and accurate; to come at ſo uſeful an Inſtrument as ſuch a Conſtruction of the Balance muſt be, I have made them in various Forms for the deſigned Purpoſes, but have found that none come up to the Deſign ſo well as the following Plan.

The Beam I make about four Inches long, and the *Fulcrum* is put on and made faſt by being rivetted with a Couple of Pins, the Parts or Pivots move in a ſmall Part of a broad Circle, equal in Diameter to the Pivots, but of five or ſix Times the Diameter in Length. So that all the Advantages laid down upon the moving of the *Fulcrum* is here gained, without the Shoulders being ſo liable to catch in the Holes. The Index or perpendicular Pin is made to put down upon the Beam, or up when in Uſe, which is all that can in any wiſe be called troubleſome, but it is made ſo certain, that it is the ſame as being faſt. The Weights, when all put together, are in the Form of a Crown Piece: The Whole of the Scales, Weights, &c. when put up for the Pocket, are no bigger nor more cumberſome than a common Leather Pen-Caſe and Ink-Stand.

The foregoing being the Reſult of my Endeavours for three Months paſt, which are offered for the ſole Uſe of the Public, in this critical and adjuſting Age, that they may be more certain of not being impoſed upon; therefore I hope for Encouragement according to the Accuracy and Cheapneſs of the ſeveral Articles and no farther; and that they might be adequate to the latter, no unneceſſary Expence has been added, under the Name of a Patent, &c. But for the Security of my Property, each of my moſt approved Inſtruments are marked with A H, or H A, in ſome Part of it.

Having now delivered what is neceſſary to know concerning the Weight and Value of Gold in general, and alſo of the current Pieces in particular, as well as the Methods how to determine the Weight or Quantity, as well as Quality, both by the Pen and with Inſtruments, for a ſpeedy and accurate Determination, it is now proper to give the Arbitrator or Determiner of Equity by what Rule the Public are to eſtimate the Quantity of Money according to the Price put upon it. It has been obſerved, that Gold and Silver are eſtimated by Troy Weight at ſo much per Ounce or Grain; but ſtill we have no Idea what thoſe Quantities are, when compared with other Bodies; ſo that it is neceſſary to know firſt the Original of the Quantity or Weight, and then to know if we have the Weight according to that Original or Standard. The Origin of the Weights uſed in England is a Grain of Wheat taken out of the Middle of the Ear when it is full dried or ripe. This undoubtedly is a good Original if Nature remains the ſame; but if a ſimilar Decay be the Caſe, in Proportion to the Time, which is the Opinion of ſome Philoſophers, then a Grain in one Age will not be of the ſame Size and Weight that it is in another, but will be diminiſhed in Proportion to the Time. This Opinion, it is true, will not bear a Controverſy; ſo that a dried Grain taken out of the Middle of the Ear may be fixed on as a Standard which has been adopted by our Predeceſſors in Government, who have authorized the Weights through England to be the ſame, and have kept the Standard ſecure in the Exchequer, under the Authority of an Officer, called the Clerk of the Market. Hence the Public may be pretty certain of the Origin of their Weights being preſerved ſecure, and alſo of a good Method of proving them. But ſtill the Matter is, Whether the Weights derived from the Origin are juſtly formed, ſo that they ſhall anſwer the intended Deſign? Government had a very great Opportunity of determining the Penny-Weight and Ounce by picking the Grains, that 24 Grains ſhould be equal to 24 Times one, and ſo of the Ounce; but that the ſame Exactneſs is obſerved in the different Weights does not appear, ſince different Sets of Weights do not agree with each other, nor do the Parts of the ſame Set agree with themſelves, not even of thoſe marked by real Authority.

The great Difficulty of coming at a Weight the ſame of one given is troubleſome, and requires more Care than the preſent common Price will pay any Man for.

I have adjuſted ſeveral Sets that have been made by good Hands, and have found them of various Weights from the Standard, ſome too heavy, and others too light, a few right or about it. To come at a Set for my own Uſe, I was obliged to take a Mean of many of thoſe made by Authority, and by that Means have got a Set that are as near as two neighbouring Grains of Wheat can be.

The Methods to come at original Weights, or equal to them, is to have Inſtruments that will move with a very ſmall Particle of Matter, or about one-thirtieth Part of a Grain, which is the leaſt that will move any Inſtrument whatever to make the Motion perceptible. I have heard of the one-hundredth Part of a Grain being a motive Force, which was true but in Idea only; for the greateſt Extream upon Trial that I have been able to go to, I find will not be perceptible with a leſs Weight than one-thirtieth Part of a Grain, and but with very accurate Inſtruments that it will make an Effect.

Inſtruments of a long Scale are beſt, and for one Arm to be longer than the other, that whatever Effect be made by the Weight in the ſhort Arm, it may be ſooner ſhewn by the long one. But ſtill this Property may be carried too far, for if the Arms vary to the Proportion of being above that of three to one, the Effects of the Weight in the ſhort Arm will not be perceptible in the long one; for if one-thirtieth Part of a Grain, or any other Weight, will only make an Effect in thoſe of equal Arms, conſequently if one Arm be increaſed more than the other, the Effect will not appear; therefore the Effects to be produced muſt be in Proportion to the Ratio of the Arms of the Inſtruments. If ſuch Inſtruments be uſed, it is eaſy to obſerve the Exceptions that may be made to them; but if the Weights be made in two Pieces, and each be as near exact as the Inſtrument will admit, then their Sum will point out any Error of the ſame; one of the Pieces ſhould be about one-twentieth Part of the whole Weight, and is beſt made by being put upon the longer End of the Inſtrument, and equipoiſed with other Weights. The Method I have uſed to aſcertain the riſing of the longer End was, that I placed a Piece of a Pendulum Spring of a Watch to the Height of the Standard, and then I knew exactly the Riſing of the Inſtrument in the making of the other Weights, and that to a more exact Determination than can be come at any other Way. This is what ſhould be done with all the ſmall Weights, but eſpecially the Grains.

Illuſtrations to ſeveral Parts of this Treatiſe, and Examples to the moſt approved Inſtruments herein deſcribed.

THE Table of ſpecific Gravity, p. 5, is formed from weighing the ſeveral Bodies in Air and Water, and then taking the Water-Weight from that in Air, gives their Difference; with which Difference, if the Air-Weight be divided, the Quotient that comes out is the ſpecific Gravity. This Rule is univerſal for all Bodies whatever, and any one may by it continue the Table of ſpecific Gravity to the Length that it is uſually carried in Treatiſes of this Sort, for no other Purpoſe than ſwelling the Bulk of the Book. Hence if any Piece of Metal be examined, and not known of what Sorts it may be compounded of, its Parts may be found, for firſt weigh the Compoſition in Air, and mark its Weight; then weigh the ſame in Water, and note its Weight alſo. Again, from the Static Weight of the Metal take the Hydroſtatic Weight, which will give the ſpecific Gravity of the Metal, and by comparing it with the ſpecific Gravity of Metals, or the neareſt to it in the Tables, the Compoſition will be found; or if pure Metal of any Sort, it will likewiſe be known.

EXAMPLE I.

Suppoſe a Guinea to weigh five Penny-Weights ſix Grains in Air, or 126 Grains, and in Water four Penny-Weights 18,041 Grains, or 114,041 Grains, it is required to know what Metal this Piece is made of, or rather what is its Value? Wrought thus,

The Air-Weight is	126
The Water ditto is	114,046
The Difference is	11,959

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Then divide thus     11,959)126,000(10,536
                            11,959
                            ------
                             64100
                             59795
                             -----
                              43050
                              35877
                              -----
                               71730
                               71754
                               -----
                                  24
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Which Operation ſhews that the ſuppoſed Guinea is not Gold; for the Standard of Gold Coin is 18,888, &c. but the Quotient is only 10,536 very near; ſo that the Guinea having the ſame ſpecific Gravity of Silver, as may be ſeen by the Tables, p. 5, is only of that Value, no Matter what may be its Compoſition.

EXAMPLE II.

Suppoſe a Johannes was offered in Payment, that weighed in Air nine Pennyweights and five Grains, or 221 Grains; but in Water it weighed only 209 Grains. Of what Metal is this Piece made of? Work as below.

The Air Weight is 221 Grains.
The Water ditto is 209 ditto.
The Difference is 12

Now divide thus 12)221
19,25, the Quotient.

So the Quotient is 19¼, or 19,25, which ſhews that the ſpecific Gravity of the Piece is very near that of fine Gold; ſo ſuch a Piece of Money would be above the Standard, and conſequently too good. If the Difference had been 15, the Quotient would have been 14,73, &c. which is a ſpecific Gravity not to be found in the Table, but is a Mean between Standard Gold and Silver; ſo the Value of the Piece muſt be taken between them in like Proportion.

The Table N° VI. is conſtructed to ſhew the hydroſtatic Weight of each current Piece of Money, and by having its Weight given in Air, either by weighing or the Table, may be found the ſpecific Gravity of each Piece, whether they be adulterated with Copper, Braſs, or a Compoſition of them all, &c. But if any Piece be found to weigh in Air and Water as that Table ſhews, then the Piece is made of the reſpective Metals, and conſequently may be eſtimated as ſuch, without any farther Trouble in calculating, &c. &c. But from a Compariſon of the hydroſtatic Weights of the ſeveral Metals, it is plain that the Difference is ſo ſmall, that the general Adulteration may be taken as the Compoſition, and then the Values will be eaſily reckoned at 2 *s.* 6 *d.* per Grain, as laid down in Table VII. *Note*, There is an Error or two in Table VI. which were cauſed through a Miſtake of placing the Figures of the Grains wrong to the Pennyweights, &c. which will be proper to correct here, as there is not any material Error beſides in the whole Work.

It is in the Column of hydroſtatic Weight of Copper, which when ſet right, is as below.

Copper Hydroſtatic Weight.

1	$0\frac{1}{2}$
1	$12\frac{9}{10}$
2	1
2	$9\frac{1}{4}$
3	$1\frac{4}{5}$
4	$2\frac{1}{8}$
4	$18\frac{1}{2}$
6	$3\frac{2}{3}$
8	$4\frac{1}{4}$
9	13
16	$8\frac{2}{3}$
23	$20\frac{2}{3}$

And for $18\frac{1}{5}$ in the Braſs Column, read $12\frac{2}{5}$: Alſo in Table VII. for *the Deficiency*, read *the Value of the Deficiency.*

Table I. after that of Specific Gravity, is for any Piece of ſuppoſed pure Gold, with its Weight in Air and Water, ſo that, as has been obſerved in its Conſtruction, if any Piece of whatever Weight within the Limits of the Table, agree both in Air and Water with the Weights in the Table, then the Piece is good, if not, it is deficient in Value in Proportion to the Adulteration, and the Metal of Adulteration.

Suppoſe a Piece of Metal was offered for Sale as ſtandard Gold, that weighed one Ounce in Air, but in Water 18 Pennyweights 10 Grains; if this Piece was good, by the Table it ſhould weigh 1 Ounce 22½ Grains, and then would be worth 4*l.* But as it weighs only 10 Grains in Water, we muſt firſt find its ſpecify Gravity, by the Examples that have been given to illuſtrate the Table of the ſame, which will be found to be 12,6, &c. which is ſomething better than fine Silver; therefore the Piece may be eſtimated as ſuch, or near it. But the real Value will be the beſt found by Table III. as the Adulteration is found to be made with Silver; for oppoſite 12 Grains deficient is 2 *l.* 6 *s.* 6½ *d.* and Half a Grain is 1 *s.* 11¼ *d.* ſo that the whole Value of the Deficiency is 2 *l.* 8 *s.* 5¾ *d.* this taken from 4 *l.* gives 1 *l.* 11 *s.* 6¼ *d.* for the full Value of the Piece of Gold.

If the ſpecific Gravity had come out near Copper, Braſs, or the Compoſition, then the Tables N° IV. V. and VII. muſt have been uſed for the Values of the Deficiency.

The Uſe of Table II. is for the current Pieces of Money, and others of leſs Value; and higher, from about 2 *s.* 6 *d.* to about 7 *l.* that may come in Uſe, which ſhews their Weight in Air and Water, with their ſtandard Difference, according to the moſt renowned Authors; ſo that if any Piece agree with the ſtandard Difference, then it is good, but if not, or loſes more, then for each Grain deficient, the ſeveral Values of Tables III. IV. V. and VII. muſt be uſed for the ſeveral Adulterations of Silver, Copper, Braſs, and the Compoſition. But as it is troubleſome, to find the ſpecific Gravity, to know whether the Adulteration be made of the ſeveral different Metals, and, as it has been ſhewn, that the Difference of the ſeveral Metals is ſo little, that the Compoſition and its Value may be uſed without any great Error in the Concluſion: therefore, for any adulterated Piece of Money, the Adulteration may be reckoned at 2*s.* 6*d.* for each deficient Grain, except that an uncommon and a very apparent Shew of one of the other Metals may be judged, then the reſpective Tables may be uſed for the Value of each deficient Grain.

Suppoſe a Six-and-thirty Piece was deficient 14 Grains more in Water than the Standard given in the Table N° II. Page 7, if it be found to be deficient from an Adulteration with the Compoſition, then for each Grain deficient reckon 2 *s.* 6 *d.* conſequently, the whole Value of the Deficiency is fourteen Times 2 *s.* 6 *d.* or 35 *s.* ſo the real Value of the Piece is only 1 *s.*

Suppoſe the ſame Piece was tried in the Slide-Rule, which is ſuppoſed to be of full Weight, and will be ſhewn on the Air-ſide, but when the Veſſel of Water is brought, the Index on the Water-ſide muſt be moved to 36 *s.* the Water-ſide. But as the Piece will be ſtill much too light, move the Index in, till the Equipoiſe is come at as near as may be; and for the more minute Part, move the little Weight, which will be ſhewn to the neareſt Diviſion required: the Diviſion of the Index for the Slider, will move down to 2 *s.* and the little Weight will be moved two Diviſions; the former counts for twelve Grains, and the latter for two; ſo the Whole is fourteen, as before. Suppoſe a Guinea be weighed, and be full Weight, then to try it in the Water, put to the Hair-Purſe, if the Inſtrument be of that Sort that has a Scale-diſh to it; then move the Water-Index for the Equipoiſe to the Mark upon the Water-ſide, which will be in this Example at 21; but if the Piece be ſtill ſhort, move the little Weight, if the Deficiency comes within its Reach, which ſuppoſe three Grains, then the deficient Value will be three Half-crowns; ſo the Value of the Guinea will only be 13 *s.* 6 *d.*

Suppoſe a Guinea was to be weighed by the Stopper-Steel-Yard with Improvements; firſt, take off the Caſe, Part of which is the Stand, that Part place upon a Table, near the Edge, then draw out the Pieces; put the ſmalleſt to its laſt Diviſion at the higheſt Figure, which is its ſtanding Mark: then hook on the other Part of the Caſe to the End of the largeſt Tube, into which put the Guinea, and move the middle Tube till the End comes up to 21; if it be full Weight, then the Inſtrument will be Equipoiſe; but if otherwiſe, move the Tube in, to bring 18 nearer, till you come as near the Equipoiſe as Sixpence; and for Parts under, move in the little Weight upon the ſmall Wire; ſuppoſe the Inſtrument ſtood at 20 on the Money-Tube, and 4 on the ſmall Wire, then the Guinea would be deficient 20 Pence.

Let a Guinea be weighed on the Dial Steel-Yard: Firſt, ſet the Hand at Figure 4, and put the Piece into the Scale, and move the Weight on the Beam till you obtain an Equipoiſe, which ſuppoſe the Weight at 20, or one below 21, and the Hand at half Way from 4 towards 3, or ſix Diviſions from 4, then the Deficiency is 1 *s.* 6 *d.*

The Joint Weighing Rule is divided into 24 equal Parts, marked with the uſual numerical Figures, each of theſe Parts is equivalent to one Shilling in Gold, and the leſſer, or Subdiviſions between them, are reckoned Grains at Twopences.

At the End of the Rule is fixed a Forceps or Pincers, to hold the Money while it is weighed.

In the Caſe that holds the Rule are contained two moveable Braſs Pieces, one of which has two ſmall Notches filed on its Sides, to receive and ſupport the Steel Pins on the Edge of the Rule; and the other ſolid Braſs Piece is to be laid on the Face of the Rule, with its ſloped Edge turned towards the Pincers, in order to aſcertain the juſt Weight or Deficiency in Weight of any Piece you want to prove. For Example, to weigh a Guinea, let thoſe Steel Pins which are under the Diviſion marked 11, be ſuſpended on the Notches of the thin Braſs Pedeſtal; put the Piece to be weighed into the Pincers, and let that End hang free over the Table, or any other Support, then take the ſolid Braſs Piece and lay it exactly upon the Line that interſects the Figure marked 21 on the Rule, with its ſloped Edge turned towards the Pincers; if the Piece be full Weight, the Rule will be in Equipoiſe, but if otherwiſe, ſhift the ſolid Braſs Piece till you obtain a Balance, and the Number of Diviſions you may have moved it from the Line on which it was firſt placed, will readily ſhew you its exact Deficiency in Grains, &c. The ſame to be done in weighing Half Guineas, or Gold Coin of leſſer Value, obſerving only to put the ſolid Braſs Piece upon the Figures on the Rule denoting its Value in Shillings.

In weighing a Moidore or 36*s.* Piece, let the Rule be ſuſpended on the Steel Pins which are under Figure 9, and on the Front-Edge of the Rule are marked the Figures anſwerable to their Value in Shillings. For Example, Place a 36*s.* Piece in the Pincers, then put the ſolid Braſs Piece upon the Rule directly over the Line marked 36 on the Front-Edge; and, if due Weight, you will find a Balance, if otherwiſe, ſhift the Braſs Piece till you obtain it, and the Number of Diviſions you may have moved it, being marked on the Front-Edge of the Rule, will exactly ſhew its Deficiency in 1, 2, or more Grains, to the Value of Two Shillings.

Suppoſe a Piece of Gold was to be weighed by the Univerſal Steel-Yard, no matter what Sort it be of, nor of what Weight; let it be put into the Diſh, and move the Weights till you obtain an Equipoiſe, which ſuppoſe to be at 20, then the Piece is worth that Number of Shillings. But the greateſt Uſe of this Inſtrument is in determining the Weight of a Number of Pieces in a ſhort Time, which ſuppoſe to be Guineas; then move the Weight to 20 for the paſſing Value, and fix the inclined Plane near the Diſh; then with the left Hand placed near the Diſh to ſteady it, and the right at the higheſt End of the inclined Plane, with the Guineas in it, which let run down one after another, and if they be worth 20 Shillings, each of them will lift the Weight, but if not, they will be ſhort, ſo may be put aſide, and the paſſing ones taken up as faſt as they come. In this Manner 200 may be weighed in one Minute at leaſt: The ſame may be done for Half or Quarter Guineas, but that they wont run ſo faſt, therefore may as well be weighed any other Way, as has been ſhewn.

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